

Chapter Eight

The Costs of Recycling and Composting

Overview

This chapter evaluates the costs of 30 diverse recycling and composting programs. The first section presents capital and operating and maintenance cost data. The second section examines the effect of program design on costs, and in the third section, we draw upon the experience of these 30 communities to offer suggestions on how communities can reduce the costs of materials recovery. The final section briefly compares communities' materials recovery operating costs to the costs they incur for refuse collection and disposal.¹

Capital and Operating and Maintenance Costs

Communities incur two types of costs when implementing a materials recovery program: capital costs and operating and maintenance (O&M) costs.

Capital costs are one-time expenditures including equipment (e.g., vehicles, household storage containers, conveyors, crushers, and balers), land, and building construction and improvements. Capital costs can be accounted for as one-time expenses or amortized over the lifetime of the equipment.

Table 8.1 lists the total capital investment in recycling and composting made by each jurisdiction. Capital costs that were picked up by public agencies outside the jurisdiction, or by the private sector, are not included in this study. Also excluded is any equipment donated or owned before the initiation of recycling and/or composting programs. While we recognize that previously owned equipment is an asset, which can be sold for cash, used for its original purpose, or used for recycling, the difficult and somewhat arbitrary task of placing an accurate dollar value on older

equipment was beyond the scope of this report. In addition, by excluding the value of previously owned equipment, capital costs figures reflect the benefit communities reap when they avoid purchasing new equipment to start recycling programs. By using previously owned equipment, communities can recover materials without the cash outlay to purchase this equipment new. Communities doing this are benefiting from reduced cash requirements as compared to communities choosing to purchase new or additional equipment. (See Integrating Materials Recovery Into Solid Waste Systems, page 140.) All the capital cost figures in Table 8.1 are expressed in 1990 dollars and represent the costs incurred only by the documented community. Table 8.2 lists capital costs on a ton-per-day recovered basis, which, in cases where complete costs are given, allows for comparison of capital investments both within our sample, and between our communities and communities employing other solid waste management options. Table 8.3 lists annualized capital costs per ton of materials recovered.² Tables 8.4 through 8.7 present capital cost data broken down into recycling collection and processing and into yard waste collection and composting, and indicate for each of these categories what these costs include and what, if any, other equipment is used for which the jurisdiction did not have a cash outlay. (Table 8.17, presented later in the chapter, lists the capital costs of intermediate processing facilities.)

Annual O&M costs are ongoing expenses that include such items as equipment leasing and maintenance, utilities, labor, administrative expenses, licenses, supplies, insurance, residue disposal, marketing fees, contract fees, and publicity programs. In this study, materials recovery O&M costs are broken down into four basic categories: collection, processing and marketing,

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Table 8.1
Communities' Capital Costs for Recycling and Composting,
in Constant 1990 Dollars (a)

Community	Recycling Capital Costs			Composting Capital Costs			Total Capital Costs
	Collection (b)	Processing (c)	Subtotal	Collection (b)	Processing (d)	Subtotal	
Austin, TX	\$503,735	\$0	\$503,735	NA	\$288,455	NA	NA
Bartley, CA	\$702,005	\$370,397	\$1,072,403	\$0	\$0	\$0	\$1,072,403
Berlin Township, NJ	\$93,705	\$0	\$93,705	\$30,130	\$13,239	\$43,369	\$137,073
Boulder, CO	\$174,085	\$0	\$174,085	\$114,000	\$375	\$114,375	\$288,460
Bowdoinham, ME	\$0	\$16,354	\$16,354	\$0	\$0	\$0	\$16,354
Columbia, MO	\$19,332	\$0	\$19,332	\$0	\$0	\$0	\$19,332
Dakota County, MN	\$7,750	\$43,574	\$51,324	\$0	\$0	\$0	\$51,324
Fennimore, WI	\$34,608	\$84,692	\$129,301	\$3,112	\$0	\$3,112	\$132,413
King County, WA	\$0	\$0	\$0	\$0	\$0	\$0	\$0
La Crescent, MN	\$8,715	\$0	\$8,715	\$0	\$24,153	\$24,153	\$32,867
Lafayette, LA	\$430,389	\$0	\$430,389	\$0	\$190,000	\$190,000	\$620,389
Lincoln, NE	\$2,500	\$0	\$2,500	\$3,700	\$90,208	\$93,908	\$96,408
Lincoln Park, NJ	\$70,440	\$15,000	\$85,440	\$18,094	\$19,488	\$37,582	\$123,022
Mecklenburg Co., NC	\$450,446	\$58,146	\$517,591	\$22,595	\$1,416,787	\$1,439,383	\$1,956,974
Monroe, WI	\$23,008	\$16,606	\$39,614	\$8,790	\$7,308	\$16,098	\$55,712
Naperville, IL	\$0	\$0	\$0	\$243,060	\$223,680	\$466,740	\$466,740
Newark, NJ	\$37,229	\$0	\$37,229	\$0	\$191,325	\$191,325	\$228,553
Parkville, PA	\$21,312	\$51,682	\$72,994	NA	NA	NA	NA
Peterborough, NH	\$0	\$33,144	\$33,144	--	--	--	\$33,144
Philadelphia, PA	\$1,788,882	\$154,121	\$1,943,003	NA	NA	NA	NA
Portland, OR	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Providence, RI	\$0	\$0	\$0	--	--	--	\$0
San Francisco, CA	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Seattle, WA	NA (e)	\$0	NA	\$0	\$0	\$0	NA
Sonoma County, CA	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Takoma Park, MD	\$83,530	\$0	\$83,530	\$83,530	\$9,000	\$92,530	\$176,060
Upper Township, NJ	\$60,394	\$0	\$60,394	\$84,053	\$1,410	\$85,463	\$145,856
Wapakoneta, OH	\$0	\$4,800	\$4,800	\$19,480	\$0	\$19,480 (f)	\$24,280
West Linn, OR	\$15,794	\$15,590	\$31,384	\$0	\$70,595	\$70,595	\$101,979
West Palm Beach, FL	\$78,185	\$0	\$78,185	NA	\$0	NA	NA

Key:

NA = Not Available -- = Not Applicable

Notes:

These capital costs represent those which are incurred by the jurisdiction and not necessarily all the costs of the equipment utilized for the program(s). For example, in Lafayette a private nonprofit group, The Recycling Foundation, operates the curbside program under contract with the City. The only collection costs incurred by the City were the contract fees and the cost of the bins. For the four counties listed above, any equipment purchased by municipalities within these counties is excluded. Tables 8.4 to 8.7 provides detailed information on what costs cover.

(a) For detailed breakdowns of equipment purchased, dates of purchase, and costs, see "In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results," Vols. I, II, and III (Washington, D.C.: Institute for Local Self-Reliance, 1992). Each capital expenditure was converted to constant 1990 dollars using producer price indices. Tables 8.4 to 8.7 provide detailed information on what costs cover.

(b) The capital investment made for equipment used to collect materials for recycling or composting.

(c) The capital investment made for equipment used to process recyclable materials in preparation for marketing to end users. Processing typically includes sorting, contaminant removal, and crushing or baling.

(d) The capital investment made for equipment used to process -- compost, chip, or mulch -- organic materials. Processing or composting equipment typically includes shredders or chippers and front-end loaders.

(e) Private hauler under contract with the City incur all the capital costs for curbside recycling. The City did purchase some equipment for its drop-off site at the transfer station; these costs are not available.

(f) A leaf loader was not used during the base year but has been included, as costs of equipment used in base year are unavailable.

Table 8.2
Capital Costs Per TPD Recovered, in Constant 1990 Dollars

Community	Collection	Recycling Processing	Subtotal	Collection	Composting Processing	Subtotal	Total Collection	Total Processing	Total Materials Recovery
Austin, TX	\$16,987	\$0	\$16,987	NA	\$54,664	NA	NA	\$8,258	NA
Berkeley, CA	\$16,324	\$8,613	\$24,937	\$0	\$0	\$0	\$14,393	\$7,594	\$21,988
Berlin Township, NJ	\$14,425	\$0	\$14,425	\$3,349	\$1,472	\$4,821	\$7,993	\$855	\$8,848
Boulder, CO	\$9,753	\$0	\$9,753	\$13,173	\$43	\$13,217	\$10,870	\$14	\$10,884
Bowdoinham, ME	\$0	\$19,327	\$19,327	\$0	\$0	\$0	\$0	\$19,327	\$19,327
Columbia, MO	\$4,778	\$0	\$4,778	\$0	\$0	\$0	NA	\$0	NA
Dakota County, MN	NA	\$1,024	NA	\$0	\$0	\$0	NA	\$512	NA
Fennimore, WI	\$27,945	\$76,460	\$104,404	\$4,788	\$0	\$4,788	\$19,974	\$50,143	\$70,117
King County, WA	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
La Crescent, MN	\$9,767	\$0	\$9,767	\$0	\$43,609	\$43,609	\$6,028	\$16,701	\$22,727
Lafayette, LA	\$45,861	\$0	\$45,861	\$0	\$9,310	\$9,310	\$14,446	\$6,377	\$20,823
Lincoln, NE	\$1,432	\$0	\$1,432	\$418	\$10,189	\$10,606	\$585	\$8,510	\$9,095
Lincoln Park, NJ	\$12,459	\$2,653	\$15,112	\$1,971	\$2,123	\$4,094	\$5,968	\$2,325	\$8,293
Mecklenburg Co., NC	\$31,419	NA	NA	NA	NA	NA	NA	NA	NA
Monroe, WI	\$7,440	\$5,370	\$12,810	\$5,481	\$4,557	\$10,037	\$6,771	\$5,092	\$11,863
Naperville, IL	\$0	\$0	\$0	\$12,894	\$11,868	\$24,761	\$5,048	\$4,646	\$9,694
Newark, NJ	\$1,419	\$0	\$1,419	\$0	\$6,691	\$6,691	\$679	\$3,489	\$4,168
Parkville, PA	\$5,748	\$13,939	\$19,687	NA	NA	NA	NA	NA	NA
Peterborough, NH	\$0	\$7,736	\$7,736	-	-	-	\$0	\$7,736	\$7,736
Philadelphia, PA	\$25,322	\$2,182	\$27,503	NA	NA	NA	NA	NA	NA
Portland, OR	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Providence, RI	\$0	\$0	\$0	-	-	-	\$0	\$0	\$0
San Francisco, CA	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Seattle, WA	NA (a)	\$0	NA	\$0	\$0	\$0	NA	\$0	NA
Sonoma County, CA	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Takoma Park, MD	\$17,101	\$0	\$17,101	\$18,008	\$1,940	\$19,949	\$17,543	\$945	\$18,488
Upper Township, NJ	\$6,214	\$0	\$6,214	\$24,721	\$415	\$25,136	\$11,010	\$107	\$11,118
Wapakoneta, OH	\$0	\$1,358	\$1,358	NA	NA	NA	NA	NA	NA
West Linn, OR	\$2,956	\$79,476	\$82,433 (b)	\$0	\$11,826	\$11,826	\$1,396	\$13,979	\$15,375
West Palm Beach, FL	\$8,048	\$0	\$8,048	NA	\$0	NA	NA	\$0	NA

Key:

NA = Not Available TPD = Tons Per Day -- = Not Applicable

Notes:

Capital cost per TPD is calculated based on 260 days of operation per year (with the exception of Lafayette's composting costs, which are based on 5 months of program operation). In actuality collection and processing schedules may vary from this. Some costs do not add up because the tonnage collected differs from the tonnage processed.

(a) Private haulers under contract with the City incur all the capital costs for curbside recycling. The City did purchase some equipment for its drop-off recycling site at its transfer station; these costs are not available.

Table 8.3
Communities' Annualized Capital Costs
for Materials Recovery, in Constant 1990 Dollars Per Ton (a)

Community	Collection	Recycling Processing	Subtotal	Collection	Composting Processing	Subtotal	Subtotal Collection	Subtotal Processing	Total Materials Recovery
Austin, TX	\$12	\$0	\$12	NA	\$21	NA	NA	\$3	NA
Berkeley, CA	\$9	\$3	\$12	\$0	\$0	\$0	\$8	\$3	\$11
Berlin Township, NJ	\$8	\$0	\$8	\$2	\$1	\$2	\$4	\$0	\$5
Boulder, CO	\$5	\$0	\$5	\$7	\$0	\$7	\$6	\$0	\$6
Bowdoinham, ME	\$0	\$7	\$7	\$0	\$0	\$0	\$0	\$7	\$7
Columbia, MO	\$2	\$0	\$2	\$0	\$0	\$0	NA	NA	NA
Dakota County, MN	NA	\$0	NA	\$0	\$0	\$0	NA	\$0	NA
Fannimore, WI	\$15	\$29	\$45	\$3	\$0	\$3	\$11	\$19	\$30
King County, WA	\$0	\$0	\$0	\$0	\$0	\$0	\$0	NA	\$0
La Crescent, MN	\$5	\$0	\$5	\$0	\$17	\$17	\$3	\$6	\$10
Lafayette, LA	\$25	\$0	\$25	\$0	\$4	\$4	\$13	\$2	\$15
Lincoln, NE	\$1	\$0	\$1	\$0	\$4	\$4	\$0	\$4	\$4
Lincoln Park, NJ	\$18	\$1	\$19	\$1	\$1	\$2	\$7	\$1	\$8
Mecklenburg Co., NC	\$17	NA	NA	NA	NA	NA	NA	NA	NA
Monroe, WI	\$4	\$2	\$6	\$3	\$2	\$5	\$4	\$4	\$8
Naperville, IL	\$0	\$0	\$0	\$5	\$5	\$10	\$3	\$5	\$7
Newark, NJ	\$1	\$0	\$1	\$0	\$6	\$6	\$1	\$2	\$3
Parkasia, PA	\$3	\$5	\$8	NA	NA	NA	NA	NA	NA
Peterborough, NH	\$0	\$3	\$3	--	--	--	\$0	\$3	\$3
Philadelphia, PA	\$84	\$1	\$85	NA	NA	NA	NA	NA	NA
Portland, OR	\$0	\$0	\$0	\$0	\$0	\$0	NA	\$0	\$0
Providence, RI	\$0	\$0	\$0	--	--	--	\$0	\$0	\$0
San Francisco, CA	\$0	\$0	\$0	NA	NA	NA	NA	NA	NA
Seattle, WA	NA	\$0	NA	\$0	\$0	\$0	NA	\$0	NA
Sonoma County, CA	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Takoma Park, MD	\$9	\$0	\$9	\$10	\$1	\$11	\$10	\$1	\$10
Upper Township, NJ	\$3	\$0	\$3	\$14	\$0	\$14	\$6	\$0	\$6
Wapakoneta, OH	\$0	\$1	\$1	\$8	\$0	\$8	\$2	\$1	\$3
West Linn, OR	\$2	\$31	\$32 (b)	\$0	\$5	\$5	\$1	\$35	\$37
West Palm Beach, FL	\$4	\$0	\$4	NA	\$0	NA	NA	\$0	NA

Key:

-- = Not Applicable NA = Not Available

Notes:

(a) Per ton annualized capital costs equals annualized capital costs divided by the annual tonnage recovered that the costs cover. Collection equipment was annualized over a 7-year period, while processing equipment was annualized over a 10-year period. No discount or financing rates were applied except in the cases of Austin, Philadelphia, Lincoln Park, and Newark where financing rates were incurred. For these communities, actual financing rates and payback periods were applied. In Austin, Eager Beaver truck and trailers were financed with a 5-year loan at an interest rate of 10.67%. All equipment in Philadelphia was amortized over 5 years at an 8.5% interest rate. The City of Newark floats bonds for the purchase of its equipment, which is amortized over a 5-year period. Lincoln Park issued bonds at a rate of 6% for a 5-year period for the purchase of one vehicle; all of its other equipment was paid in full at the time of purchase.

(b) This applies to drop-off equipment and tonnage only, which represents 1% of the total amount of recyclables collected and processed in the City in 1990.

Table 8.4
Communities' Capital and O&M Costs for Collecting Recyclables

Community	Annual Tonnage (a)	Households Served	Per Ton O&M Cost (b)	Capital Costs (1990 \$)	Description
Austin, TX	7,710	110,000	\$95	\$503,735	Capital costs cover 13 trucks, 11 trailers, and 6,000 buckets, but exclude two trucks and 20,000 buckets purchased and used after the base year. O&M costs include one drop-off at the landfill run privately under contract with the City, and municipal curbside collection of five materials weekly with two-person crews.
Berkeley, CA	11,181	40,000	NA	\$702,005	Capital costs include six recycling trucks, one commercial recycling vehicle, 70 curbside truck bins, six scales, and 50,000 waxed tote boxes. O&M costs in Table 8.9 cover one- to two-person nonprofit crews under contract with the City to collect four materials weekly; municipal commercial curbside collection; and one buy-back and two drop-offs under contract with the City. Collection and processing cost the City \$63 per ton in O&M; collection costs alone are not available.
Berlin Township, NJ	1,689	2,000	\$43	\$93,705	Capital costs include seven trucks (shared between recycling, composting, and the DPW), one recycling trailer, and one loader. O&M costs include collection of 13 materials weekly by public crews; there is one public unstaffed drop-off site.
Boulder, CO	4,641	25,500	\$51	\$174,085	Capital costs include 31,500 recycling bins and exclude 4,000 bins purchased and used after the base year and 10 privately owned trucks. O&M costs cover contract fees paid for two-person crews to collect four materials weekly.
Bowdoinham, ME	288	290	\$23	\$0	No capital costs are incurred for collection. O&M costs cover one drop-off center open three days per week. (Drop-off center equipment is included under processing capital costs.)
Columbia, MO	1,052	7,060	\$49	\$19,332	Capital costs include one trailer and one pick-up truck. The cost incurred in 1982 for a packer truck used for recycling in 1990 is not included. O&M costs cover two-person public crews to collect seven materials monthly.
Dakota County, MN	NA	80,000	NA	\$7,750	Capital costs cover a truck used for office paper collection. The County incurred \$643,873 in O&M costs paid to municipalities to support recycling collection programs. The tonnage recovered as a result of these payments is not available.
Fennimore, WI	322	970	\$39	\$34,608	Capital and O&M costs cover collection of 10 materials every other week with a two-person public crew in a retrofitted truck, and one public drop-off center.
King County, WA	1,965	NA	NA	\$0	Recyclables are primarily collected by the private sector. The County spent \$102 a ton to collect and process 1,965 tons through its drop-off program; collection costs alone are not available.
La Crescent, MN	232	1,568	\$111	\$8,715	Capital costs cover 1,400 recycling bins and exclude equipment used by the contracted hauler. O&M costs cover contracted 3-person crews to collect 10 materials weekly. The County incurs the cost of collection at the City drop-off sites (77 tons in 1990).
Lafayette, LA	2,440	27,500	NA	\$430,389	Capital costs cover 78,000 recycling bins and exclude four trucks, and four trailers owned by the private hauler, a local nonprofit group. O&M costs cover contract fees paid to this group to collect six materials weekly with three-person crews. The City incurred \$39 a ton for collection and processing.
Lincoln, NE	454	622	\$24	\$2,500	Capital costs include 18,000 cornstarch bags and exclude 10 EWI Fivestar roll-off bins purchased by the private sector. The private sector incurs most of the capital costs for recyclables collection. O&M costs cover a one-person crew under contract with the City to pick up two materials weekly, and one drop-off collection contract with the City.

Table 8.4
Communities' Capital and O&M Costs for Collecting Recyclables (cont.)

Community	Annual Tonnage	Households Served	Per Ton O&M Cost	Capital Costs (1990 \$)	Description
Lincoln Park, NJ	1,470	4,260	\$49	\$70,440	Capital costs include a dump truck (shared with composting), one roll-off truck, 11 roll-off containers, lumber and metal beams, one hydraulic tailgate, and three self-dumping hoppers, but exclude one donated packer truck. O&M costs cover a three-person public crew to collect newspapers monthly, and one public drop-off.
Mecklenburg Co., NC	3,802	110,000	NA (c)	\$459,446	Capital costs include three front-end loaders, two Cube Vans, two roll-off trucks, one truck, one trailer, two forklifts, and 40 bins for the County's drop-off sites and its office building collection program. O&M costs, which cover 16 drop-off sites, are not available because collection costs cannot be separated from processing. (Charlotte incurs O&M costs of \$96/ton for curbside collection and additional capital costs.)
Monroe, WI	804	3,900	\$41	\$23,008	Capital costs cover 4,500 recycling bins and exclude two dump trucks and barrels purchased before the onset of the program, as well as a Kann Curbortier purchased and used after the base year. O&M costs cover a one-person public crew to collect 14 materials weekly, and one public drop-off.
Naperville, IL	7,617	24,500	\$73	\$0	Capital costs are incurred by private haulers under contract with the City. O&M costs cover contract fees for a nonprofit three-person crew to collect 12 materials weekly.
Newark, NJ	6,823	90,000	\$109	\$37,229	Capital costs cover one recycling vehicle used to pick up four different recyclable materials collected on alternative weeks, but exclude a packer truck used to collect commercial corrugated cardboard purchased prior to the onset of this program, as well as capital costs incurred by contracted haulers. O&M costs cover contract fees to two private haulers collecting 47 percent of public sector materials weekly; and the City's labor costs to run a drop-off site, and to collect commercial corrugated cardboard.
Perkasie, PA	964	3,500	\$50	\$21,312	Capital costs cover one trailer, modifications to a truck, a security fence, steel barrels, and recycling buckets. O&M costs cover two- to four-person public crews to collect glass and aluminum weekly and newspapers and mixed paper monthly, and one public drop-off center.
Peterborough, NH	1,114	1,800	NA	\$0	The Town incurs no capital costs for collection. It incurs O&M costs of \$45/ton for collection and processing (covers drop-off only); collection cost cannot be divided from processing.
Philadelphia, PA	48,368	159,245	\$107	\$1,788,882	Capital costs cover 21 Lodal trucks, 178,987 buckets, 13 Eager Beaver trucks, seven 15-cubic-yard trucks, a tractor trailer, and 60 igloos. O&M costs cover the collection of six materials weekly by three-person public crews at a cost of \$173 per ton, and the private collection of 30,000 tons of food waste, which is subsidized by the City at a cost of \$67 per ton.
Portland, OR	180,695	201,900	\$0	\$0	The private sector primarily incurs capital and O&M costs. Metro (serving a multi-county area) owns 2 drop-off sites.
Providence, RI	8,171	56,423	\$105	\$0	Providence does not directly incur capital costs. The private hauler purchased nine recycling trucks. Recycling bins are supplied by the State. O&M costs cover the collection of 10 materials weekly by a one-person crew under contract with the City.
San Francisco, CA	NA	169,000	\$0	\$0	Capital and O&M costs are incurred by the private sector.
Seattle, WA	53,775	121,546	NA	NA	Capital costs are incurred by the private haulers contracted for curbside collection. The City incurs O&M and some capital costs for materials collected at the transfer station. Collection O&M costs cannot be separated from processing costs; the City spent \$47/ton for both. The City incurs contract fees to have one-person crews pick up nine materials weekly in half of Seattle and one-person crews pick up seven materials monthly in the other half of Seattle.

Table 8.4
Communities' Capital and O&M Costs for Collecting Recyclables (cont.)

Community	Annual Tonnage	Households Served	Per Ton O&M Cost	Capital Costs (1990 \$)	Description
Sonoma County, CA	4,063	NA	NA	\$0	No capital costs are incurred by the County because recycling collection is carried out by the private sector. The O&M costs cover the contract fees paid to operate the recycling centers located at the County landfill and the transfer stations. Collection costs cannot be separated from processing costs; the County incurred \$12/ton for both.
Takoma Park, MD	1,270	4,100	\$97	\$83,530	Capital costs include 5,400 buckets and one Curb Sorter Truck, but exclude buckets and one recycling truck purchased and used after the base year, as well as three compactor trucks used 10 percent for recycling, which were owned prior to the City's recycling program. O&M costs cover three-person public crews that pick up six materials weekly.
Upper Township, NJ	2,527	4,082	\$71	\$60,394	Capital costs cover 500 bins and a compactor truck but exclude another compactor truck bought after the base year. O&M costs cover the collection of fourteen materials with a three-person public crew, and one unstaffed public drop-off center.
Wapakoneta, OH	919	3,548	NA	\$0	Capital costs are not incurred by the Town. A packer truck bought prior to the program is used for commercial recycling and is not included in the capital cost. O&M costs are incurred by the private nonprofit drop-off but are unavailable because collection costs could not be separated from processing.
West Linn, OR	1,389	6,165	NA (d)	\$15,749	Capital costs include 5,300 collection containers but exclude a recycling truck, a packer at 20 percent use, and a compactor owned by the private hauler as well as a Curb Sorter truck purchased and used after the base year. O&M costs for curbside collection (\$114/ton) are not incurred by the City. O&M cost for drop-off collection is incurred by the City but the costs for recycling cannot be separated from composting.
West Palm Beach, FL	2,526	19,194	\$148	\$78,185	Capital costs cover 18,306 recycling bins and 147 containers but exclude 100 containers and 6 trucks owned by the Solid Waste Authority. O&M costs cover one-person public crews picking up six materials weekly.

Notes:

(a) Tonnage given above represents the annual tonnage collected that the costs cover in the base year and do not necessarily represent the total amount of materials recycled in the community.

(b) Per ton O&M costs reflect average annual O&M costs incurred in the base year of study divided by the annual tonnage collected that these annual costs cover.

(c) The County incurred \$626,636 to (1) collect and process 3,802 tons at its drop-off sites and through its office building collection program and (2) process another 17,356 tons collected by the City of Charlotte and Mint Hill.

(d) The City incurred \$31 per ton in O&M costs to collect and process 51 tons of recyclables and 1,552 tons of yard waste at its drop-off site.

Table 8.5
Communities' Capital and O&M Costs for Processing Recyclables

Community	Annual Tonnage (a)	Per Ton O&M Cost (b)	Capital Costs (1990 \$)	Description
Austin, TX	7,710	\$0	\$0	Processing capital and O&M costs are incurred by the private sector.
Berkeley, CA	11,181	NA	\$370,397	Capital costs cover a horizontal baler, four forklifts (including two paid for by private contractors), an aluminum separator, and a glass conveyor but exclude a 40-foot conveyor system (purchased and used after the base year) used at the medium-technology nonprofit facility. Collection and processing cost the City \$63 per ton in O&M; processing costs alone are not available.
Berlin Township, NJ	1,689	\$10	\$0	The Township owns no processing equipment. Commingled materials are taken to the medium-technology County facility, where they are tipped for free. O&M costs cover the fee for marketing newspaper and mixed paper to waste paper brokers.
Boulder, CO	4,641	\$5 (c)	\$0	Capital costs are covered by the private sector. A baler, a truck scale, two forklifts, a front-end loader, a magnet-sorting conveyor, a semi-tractor trailer, a hopper, and two utility trucks are used at the medium-technology private facility. O&M costs cover the contract fee paid to a nonprofit group.
Bowdoinham, ME	220	\$124	\$15,835	Capital costs cover a dual-axle trailer, a baler, five storage bins, a loading ramp, two pallet trucks, a barrel jack, an electric hoist, and a chain hoist, but exclude a sorting conveyor, 81 pallet boxes, and a converted chicken barn (which are leased), and a fire truck purchased prior to the program's existence. O&M costs cover processing at the medium-technology municipal facility.
Columbia, MO	1,052	\$0 (d)	\$0	The private sector incurs capital and O&M costs. Three balers, a shredder, two conveyor systems, two front-end loaders, a trailer, three forklifts, four digital scales, and a truck scale are used at the medium-technology processing center.
Dakota County, MN	11,061	\$81	\$43,574	Capital costs cover only equipment that the County purchased for its privately operated medium technology facility — a baler, two shredders, and two conveyors used for animal bedding — and represent only 18% of the total cost of the processing facility. The contracted facility operator paid for the other 82%. O&M costs cover a contract fee paid to private processors.
Fennimore, WI	322	\$83	\$94,692	Capital costs cover a newsprint baler, a forklift, a skidloader, a cardboard baler, a paper shredder, a glass crusher, and remodeling of the building used at the medium-technology municipal facility. O&M costs cover municipal processing.
King County, WA	NA	NA	\$0	Recyclables are processed primarily by the private sector; capital and O&M costs are thus not available. The County did incur \$102 per ton in O&M costs for collecting and processing 1,965 tons through drop-off sites.
La Crescent, MN	309	\$0 (e)	\$0	Houston County processes recyclables free of charge for the municipality which, therefore, incurs no capital or O&M costs. An Alcon building (IPC), a bobcat, a pallet lifter, three balers, two shredders, a glass crusher, a magnetic separator, an aluminum blower and flattener, two self-dumping hoppers, five scales, and other equipment such as hard hats, tools, forklifts, and grinders are used at the medium-technology facility.

Table 8.5
Communities' Capital and O&M Costs for Processing Recyclables (cont.)

Community	Annual Tonnage	Per Ton O&M Cost	Capital Costs (1990 \$)	Description
Lafayette, LA	2,440	NA	\$0	The City incurred no capital costs. O&M costs cover a contract fee paid to private processors, but the processing cost cannot be separated from the collection cost (the City incurred \$39 a ton for both). A truck scale, a vertical baler, a glass crusher, a conveyor belt, a CP Manufacture 600 Densor, and a forklift are used at the private low-technology processing facility.
Lincoln, NE	30	\$15	\$0	Capital costs are incurred by the private sector. O&M costs cover the contract fee paid to the private processor.
Lincoln Park, NJ	1,470	\$5	\$15,000	Capital costs cover two used balers and a plastic compactor used at the drop-off. O&M costs cover minimal processing before materials are delivered directly to markets.
Mecklenburg Co., NC	18,610	\$8	\$58,146	Capital costs cover two vertical balers and a forklift (the tonnage these costs cover is not available). They exclude balers, hoppers, three conveyors, three skid steer loaders, and two forklifts, all of which are owned and used by the private contracted processor. O&M costs cover the tipping fee the County paid to the private medium-technology processor for materials collected at curbside and at the drop-offs (18,610 tons). The County's per ton O&M cost for processing another 2,545 tons of white goods and other recyclables collected at the landfill are not available.
Monroe, WI	804	\$45	\$16,606	Capital costs cover two balers and 10 dumping hoppers. O&M costs cover low-technology municipal processing.
Naperville, IL	7,617	\$43	\$0	Capital costs are not incurred by the City but by the medium-technology contracted processor. O&M costs cover a contract fee paid to this nonprofit group.
Newark, NJ	6,823	\$0 (f)	\$0	The private sector incurs all capital and O&M costs.
Perkasie, PA	964	\$10	\$51,682	Capital costs cover a conveyor, a can crusher, and a recycling building. O&M costs cover low-technology municipal processing.
Peterborough, NH	1,114	NA	\$33,144	Capital costs cover two downstroke balers, a conveyor, a forklift/truck, a used plastic granulator, and a chop saw, but exclude a donated band saw. The Town incurred \$45 per ton in O&M costs for collection and processing of materials delivered to the Town drop-off center. Processing costs alone are not available.
Philadelphia, PA	48,368	\$8	\$0	Private processors incur all Capital costs. O&M costs cover the contract fee paid to the medium-technology processors.
Portland, OR	180,695	\$0	\$0	The private sector primarily incurs all capital and O&M costs. Metro (serving a multi-county area) owns two drop-off sites in the City.
Providence, RI	8,171	\$0 (g)	\$0	The State incurs all processing costs at its high-technology processing system, which employs Bezner equipment.

Table 8.5
Communities' Capital and O&M Costs for Processing Recyclables (cont.)

Community	Annual Tonnage	Per Ton O&M Cost	Capital Costs (1991 \$)	Description
San Francisco, CA	NA	\$0	\$0	The private sector incurs all capital and O&M costs.
Seattle, WA	53,775	NA (h)	\$0	Two contracted companies incur capital costs. O&M costs cover the contract fees, which in turn cover both collection and processing. The City incurred \$47/ton for curbside and transfer station programs.
Sonoma County, CA	4,063	NA	\$0	The private sector incurs capital costs. A densifier, a forklift, two scales, and a baler are used by a contracted nonprofit group to process the material collected through the two County drop-off centers, a mobile drop-off/buy-back service, and two independent drop-off/buy-back centers. The County spent \$12/ton to collect and process recyclables recovered at its drop-off sites; processing costs alone are not available.
Takoma Park, MD	1,270	\$15	\$0	The private sector incurs capital costs. O&M costs in the base year cover the fees paid to a private company for hauling plastic, glass, and cans to processors. The City now delivers its recyclables to a new high-technology County facility, which employs Bezner equipment.
Upper Township, NJ	2,527	\$0 (i)	\$0	The County incurs capital and O&M costs. The Township tips materials at the medium-technology County facility free of charge.
Wapakoneta, OH	1,369	NA	\$4,800	Capital costs cover a can crusher and a glass crusher but exclude a baler, a used forklift truck, a scale, and a trailer, which were paid for by the County. The County incurs O&M costs.
West Linn, OR	51	NA (j)	\$15,590	Capital costs cover those for the drop-off site (a front-end loader (20 percent use) and two drop boxes), but exclude a donated drop box and sorting conveyor. The pre-sorted materials are generally delivered directly to market. The City's O&M costs cannot be separated from its composting costs.
West Palm Beach, FL	2,526	\$0 (k)	\$0	The County incurs the capital and O&M costs. A forklift, a sweeper attachment, two bobcats, a grapple attachment, a ramp master, three vertical balers, two pallet jacks, five glass breakers, interim IPC buildings, a scale, five conveyor belts, and two aluminum can crushers are used at the medium-technology facility.

Notes:

(a) Tonnage given above represents the annual tonnage processed that the costs cover in the base year, and do not necessarily represent the total amount of materials processed by either the community or the processing facility.

(b) Per ton O&M costs reflect average annual O&M costs incurred in the base year of study divided by the annual tonnage processed that these costs cover. Costs, including those reported in notes (c) through (k), represent gross costs and therefore exclude revenue from sale of materials.

(c) Eco-Cycle incurred \$37 per ton.

(d) Civic Recycling incurs this cost, which is unavailable.

(e) Houston County incurs \$104 per ton.

(f) REI Distributors incurred about \$9 per ton for processing.

(g) The State incurs \$32 per ton.

(h) The Recycle America Processing Center incurred approximately \$30 per ton in 1989.

(i) Cape May County incurred \$80 per ton for processing.

(j) The City incurred \$31 a ton in O&M costs to collect and process recyclables and yard waste at its drop-off site.

(k) The Solid Waste Authority of Palm Beach County incurred \$26 per ton in the base year of study and \$21 a ton when its new facility opened in 1991.

Table 8.6
Communities' Capital and O&M Costs for Collecting Yard Waste

Community	Annual Tonnage (a)	House- holds Served	Per Ton O&M Costs (b)	Capital Costs (1990 \$)	Description
Austin, TX	1,372	110,000	\$4	NA	Capital costs are not available because the City uses 1 to 40 compactor trucks (@ approx. \$55,000 each) in a given week. O&M costs cover three-person public crews to collect bagged leaves weekly Nov.-Dec.
Berkeley, CA	1,500	2,600	\$94	\$0	A packer truck is used, but it was purchased prior to the initiation of the program, so the cost is not included. O&M costs cover one-person public crews to collect leaves, grass clippings, brush, and Christmas trees in bags or carts every other week.
Berlin Township, NJ	2,339	1,800	\$7	\$30,130	Capital costs cover four trucks (shared with recycling and the DPW) and two leaf loaders. O&M costs cover two-person public crews collecting grass clippings and other yard waste in cans or bags weekly year-round, and three-person crews collecting loose leaves in fall and spring with a special scoop.
Boulder, CO	2,250	35,000	\$54 (c)	\$114,000	Capital costs cover four front-end loaders and 20 trucks (both at six percent of the time) and five dump trucks whose cost and purchase dates are not available. In addition, the City paid contractors for the use of 10 tractor trailers (included in O&M). O&M costs cover City and contracted crews to collect brush during spring clean-up over a three-week period.
Bowdoinham, ME	7.5	880	\$0	\$0	In the base year of study, the Town composted only 7.5 tons, which residents dropped off at the Town landfill. The Town incurred no collection costs.
Columbia, MO	41	NA	\$40	\$0	The City incurred no capital costs. One packer is used when City crews collect Christmas trees.
Dakota County, MN	11,051	70,000	\$0	\$0	County does not incur capital or O&M costs. Private haulers collect yard waste bagged or loose in compactor trucks.
Fennimore, WI	169	970	\$60	\$3,112	Capital costs include a dump truck used 10 percent of the time. O&M costs cover two-person public crews to collect piled or loose leaves, brush, and wood waste. Brush and wood waste are collected monthly year-round, leaves are collected two to three times in the fall. Tonnages are for leaves only; brush and wood waste are burned.
King County, WA	2,023	NA	\$71	\$0	The County did not incur capital costs. O&M costs cover 1,323 tons of yard waste and 700 tons of Christmas trees collected through various drop-off programs serving certain areas of the County. Costs for yard waste collected at curbside from 200,000 households is incurred by the private sector.
La Crescent, MN	144	1,568	\$0	\$0	The City incurs no capital and O&M costs because yard waste is only collected at its drop-off site.
Lafayette, LA	2,211	27,500	\$73 (d)	\$0	Capital costs are not incurred by the City. The hauler owns three compactor trucks. O&M costs cover contracted three-person crews to collect leaves, grass clippings, brush, Christmas trees bagged, bundled, or in containers weekly, year-round.
Lincoln, NE	2,302	(e)	\$14 (f)	\$3,700	Capital costs cover 3,700 paper bags. O&M costs cover the collection of 372 tons of leaves, grass clippings, and brush at curbside by contracted one-person crews weekly July through Nov. 1,930 tons were collected at municipal drop-off sites.

**Table 8.6
Communities' Capital and O&M Costs for Collecting Yard Waste (cont.)**

Community	Annual Tonnage	Households Served	Per Ton O&M Costs	Capital Costs (1990\$)	Description
Lincoln Park, NJ	2,387	(g)	\$16	\$18,094	Capital costs cover two vacuums and a dump truck used 30 percent of the time. O&M costs cover two-person City crews to collect bagged leaves and grass clippings at least two times per month in April, May, October, and November. Loose leaves are picked up as needed with a vacuum pulled by a dump truck. 40 percent of yard waste was collected at the public drop-off site.
Mecklenburg Co., NC	N A	N A	NA	\$22,595	Capital costs cover 50 percent of the maintenance service truck, which is shared with the recycling program. The County operates a drop-off site for yard waste at the landfill, but O&M costs are not available.
Monroe, WI	417	3,900	\$67	\$8,790	Capital costs cover a jeep and a sweeper attachment but exclude a packer truck. O&M costs cover one-person public crews to collect bagged grass clippings and brush weekly April to November, and to collect leaves weekly from October 15 to Thanksgiving.
Naperville, IL	4,901	24,500	\$77 (h)	\$243,060	Capital costs cover a J.D. Loader, four brush chippers, and two leaf loaders, but exclude two vacuum sweepers at 20 percent use (purchased 1975) and any equipment used by the private contractors. O&M costs cover a public crew to collect loose leaves and brush three times per year, and Christmas trees. O&M costs also cover contract fees for collection of bagged grass clippings and other garden waste weekly April through December.
Newark, NJ	7,435	NA	\$10	\$0	The City incurs no capital costs. O&M costs cover contract fees with three private haulers to collect leaves, grass clippings, brush, and Christmas trees at curbside weekly from October through January. All households are served as needed.
Perkasie, PA	654	3,500	\$36	NA	Capital costs are not available. O&M costs cover three to five public workers to collect leaves with vacuums and dump trucks weekly from late October through November, and brush monthly on an on-call basis.
Peterborough, NH	0	0	--	--	Peterborough has no composting program. Brush and wood are burned.
Philadelphia, PA	1,571	45,000	NA	NA	Capital costs are not available, but two vacuum leaf loaders, six tractor and trailers, two large loaders, 10 mechanical brooms, and a compactor truck are used for composting and various Streets Department activities. Three- to five-person public crews collect leaves once in four neighborhoods November through December and also collect Christmas trees. O&M costs are not available.
Portland, OR	411	NA	\$0	\$0	The private sector incurs capital and O&M costs. (Only some haulers offer yard waste collection service.)
Providence, RI	0	0	--	--	Providence has no composting program.
San Francisco, CA	172	NA	\$35	\$0	The City does not have curbside service for yard waste. \$35 per ton figure covers the City's O&M cost to collect and chip Christmas trees in 1990.
Seattle, WA	36,781	94,805	\$65 (i)	\$0	The City incurs no capital costs. O&M costs cover contract fees. Two private contractors collect bagged, bundled, or containerized leaves, grass clippings, brush using one-person crews and rear-loading packer trucks. North section is serviced weekly year-round. South section is serviced biweekly March through October and monthly the rest of the year.

Table 8.6
Communities' Capital and O&M Costs for Collecting Yard Waste (cont.)

Community	Annual Tonnage	House- holds Served	Per Ton O&M Costs	Capital Costs (1990 \$)	Description
Sonoma County, CA	83	1,200	\$0	\$0	The County does not incur capital or O&M costs. The City of Santa Rosa began a pilot curbside yard waste collection program in Sept. 1990. It served 1,200 households and collected 83 tons of wood and yard waste in 1990. Almost 2,000 tons of yard waste was composted in the County in 1990.
Takoma Park, MD	1,206	4,100	\$76	\$83,530	Capital costs cover three compactor trucks at 10 percent use, five leaf vacuums, and four 15-cubic-yard leaf collection boxes. O&M costs cover three-person public crews to collect bagged leaves, grass clippings, and Christmas trees weekly year-round (starting June 1990) and five-person crews to collect loose leaves in the fall.
Upper Township, NJ	884	3,860	\$49	\$84,053	Capital costs cover two leaf vacuums and a compactor truck. O&M costs cover two-person public crews to collect leaves weekly year-round and grass clippings, wood waste, brush, Christmas trees weekly spring to November. Loose leaves are collected in November and December. Two-person crews collect and chip large brush.
Wapakoneta, OH	455	3,548	\$45	\$19,480	Capital costs cover a leaf loader truck and a dump truck at 8 percent use. O&M costs cover this collection but also include some activities at the compost site. The City collects leaves at the curb during November and December.
West Linn, OR	4	5,300	\$0	\$0	The City incurs no capital and O&M costs for curbside collection; these are picked up by a private hauler. In total, 1,552 tons were collected in 1990 through curbside and drop-off (but only 4 tons through curbside).
West Palm Beach, FL	16,703	18,306	\$37	NA	Capital costs are not available, but three compactor trucks, five cranes, and 10 Lightning Loader Trucks are used. O&M costs cover two-person public crews to collect leaves, grass clippings, brush, wood waste, and Christmas trees, two times per month, year-round.

Key:

-- = Not Applicable NA = Not Available

Notes:

- (a) Tonnage given above represents the annual tonnage of yard waste collected covered by the listed costs, and do not necessarily represent the total amount of materials collected.
- (b) Per ton O&M costs reflect average annual costs incurred in the base year of study divided by the annual tonnage collected that these annual costs cover.
- (c) Includes cost of composting.
- (d) Contract fee is based on a per household cost.
- (e) 2,000 households were served by the pilot curbside program.
- (f) Curbside yard waste collection cost the City \$32 per ton (\$11,966). Drop-off collection of yard waste and Christmas trees cost the City on average \$11 per ton.
- (g) 1,424 tons of yard waste were collected at curbside from 2,772 households; the other 963 tons were collected at the drop-off site.
- (h) Leaf and brush collection costs the City \$64/ton and \$84/ton, respectively. The private hauler is paid the equivalent of \$111 per ton for refuse and yard waste collection, and \$120 per ton for Christmas tree collection.
- (i) The City paid U.S. Disposal \$84.29/ton to collect and compost yard waste in 1990, and General Disposal \$56.36/ton for collection alone. U.S. Disposal collected 36,781 tons and General collected 10,845 tons.

Table 8.7
Communities' Capital and O&M Costs for Composting

Community	Annual Tonnage (a)	O&M Per Ton Costs (b)	Capital Costs (1990 \$)	Description
Austin, TX	1,372	\$56	\$288,455	Capital costs cover a windrow turner, a front-end loader, a conveyor, and screens. O&M costs cover a municipal high-technology co-composting site, temperature testing, turning rows 2 times per week, and screening compost.
Berkeley, CA	1,600	\$24.75 (C)	\$0	Capital costs are not incurred by the City. One packer truck is used 50 percent of the time. O&M cost listed is the tipping fee paid to the private high-technology facility. Recycled Wood Products uses a tub grinder; material is watered, screened, windrowed, turned weekly, temperature monitored, and tested.
Berlin Township, NJ	2,339	\$2	\$13,239	Capital costs cover a chipper and exclude a windrow turner. O&M costs cover the medium-technology municipal site. Windrows are turned once per month.
Boulder, CO	2,250	NA	\$375	Capital costs cover 15 backyard composting bins. Brush is chipped with a tub grinder owned by a private contractor. O&M costs for municipal brush chipping are not available because processing cost cannot be separated from collection.
Bowdoinham, ME	8	NA	\$0	The Town had not incurred any capital costs through the base year, but has since purchased a shredder. A municipal drop-off is located at the landfill where the compost is piled (low-technology processing), but O&M costs are not available.
Columbia, MO	NA	NA	NA	Capital and O&M costs are not available. There is a municipal drop-off site for low-technology mulch production.
Dakota County, MN	11,061	\$33	\$0	Capital costs are not incurred by the County. Operator owns all equipment for the medium-technology processing facility, including three conveyors, a trommel screen, a clump breaker, a tub grinder, a Seppi tree/brush chopper, a skid-steer loader, a front-end loader, and a trackdozer. O&M costs are contract fees paid to the private company that operates the two County-owned yard waste composting sites. Workers empty bags, mix contents with soil, use clump breakers, pile, and repeat the process.
Fennimore, WI	169	\$13	\$0	The City incurred no capital costs, although it uses one 1975 front-end loader, purchased prior to the program. O&M costs cover medium-technology municipal processing. Dropped off yard waste is windrowed and turned each week. Leaves picked up at curbside are spread on a local farm.
King County, WA	2,023	\$25 (C)	\$0	The County incurs no capital costs. O&M costs cover the tipping fees paid to four private composting sites with varying processing technologies.
La Crescent, MN	144	\$12 (d)	\$24,153	Capital costs cover a front-end loader used 40 percent of the time. O&M costs cover low-technology processing (turning of the pile 3-4 times per year). Drop-off site is open from April through October.
Lafayette, LA	2,211	\$17 (e)	\$190,000	Capital costs cover a tub grinder and front-end loader. O&M costs cover City-owned and -operated medium-technology site. The yard waste is unloaded on an asphalt pad, ground with a tub grinder, windrowed, temperature monitored, and reformed.
Lincoln, NE	2,302	\$14	\$90,208	Capital costs cover a front-end loader (used 10 percent of the time) and a chipper. The medium-technology site is owned and operated by the City. O&M costs cover rental of a tub grinder and the grinding, windrowing, and weekly turning of yard waste.
Lincoln Park, NJ	2,387	\$3	\$19,488	Capital costs cover two chippers purchased in 1982 for brush, now used only for Christmas trees. O&M costs cover tipping fees for yard waste at the medium-technology County processing facility. The Borough brings leaves and grass clippings to two local composting facilities (one County facility at \$3.71/cy and one municipal facility at no charge) and brush to three private chipping/composting sites. The Ox Stump Factory charges \$8/cy.

Table 8.7
Communities' Capital and O&M Costs for Composting (Cont.)

Community	Annual Tonnage	O&M Per Ton Costs	Capital Costs (1990 \$)	Description
Mecklenburg Co., NC	NA	NA	\$1,416,787	Capital costs cover a pick-up truck, a tub grinder, a windrow turner, two tub grinders, a steer loader, a tractor loader, a shredder, four dump trucks, and two wheel loaders but excludes two conveyors, a tractor loader, and a trommel screen purchased and used after the base year. The county purchased most of this equipment as a result of Hurricane Hugo. O&M costs are not available. The yard waste is windrowed, turned, and cured at the medium-technology County facility.
Monroe, WI	417	\$18	\$7,308	Capital costs cover a chipper. O&M costs cover a tub grinder rental fee at the City-owned and -operated low-technology site. Materials are mixed, ground, and formed into a large pile, which is turned 4 times per year. Christmas trees are chipped.
Naperville, IL	4,901	\$27	\$223,680	Capital costs include a dump truck, a windrow turner, and a tractor but exclude a spreader truck bought in 1977 (cost is not available). O&M costs cover windrowing, temperature monitoring, turning as needed (once per week in the summer), and watering as needed at the municipal high-technology site. Christmas trees are chipped.
Newark, NJ	7,435	\$11	\$191,325	Capital costs cover a chipper (6 percent use), a front-end loader, and a shredder-mixer. The medium-technology site is municipally owned and operated. O&M costs cover the rental of a screen-all and windrowing of leaves and grass clippings, watering once per month, and turning every 2 weeks. Finished compost is screened. Christmas trees are chipped with a borrowed chipper.
Perkasie, PA	654	\$0	NA	Capital costs are not available. The Borough delivers leaves to a farm 2 miles away, where they are windrowed and turned with a back hoe (medium-technology processing). Some leaves are also delivered to a landscaping company. Brush chipped at curbside is simply deposited in piles at local parks.
Peterborough, NH	0	--	--	The Town had no composting program during the base year.
Philadelphia, PA	1,006	\$89	NA	Capital costs are not available, but front-end loaders and a windrow composter are used. The medium-technology site is City-owned and -operated. O&M costs cover the salaries of three employees but exclude the costs of fuel and of windrowing and turning the leaves weekly, which are not available.
Portland, OR	19,054	\$0	\$0	The City incurs no costs. There are at least two private composting sites in the metro area that accept yard waste from residents and private businesses. Grimm's charges between \$4 and \$6.5/cy; MacFarland Bark charges \$35 per ton.
Providence, RI	0	--	--	Providence has no composting program.
San Francisco, CA	6,578	\$13	\$0	The City incurs no capital costs. O&M costs cover a backyard composting program. In 1990 the City budgeted \$83,000 for backyard composting. The tonnage composted is estimated.
Seattle, WA	38,900	\$17	\$0	Seattle incurs no capital costs. O&M costs cover the tipping fee (\$5.47 to tip the first 24,000 tons and \$18/ton for any tonnage above that) paid to a private medium-technology processor for yard waste collected by the contractor, General Disposal. U.S. Disposal (the other contracted service provider) delivers yard waste directly to the privately owned and operated medium-technology Cedar Groves Compost Facility.
Sonoma County, CA	1,972	NA	\$0	Capital costs are not incurred by the County. Yard waste is composted at the Bennet Valley Farm, where it is screened and windrowed. The County also operates a Christmas tree chipping recovery program, but the per ton cost is not available.

Table 8.7
Communities' Capital and O&M Costs for Composting (Cont.)

Community	Annual Tonnage	O&M Per Ton Costs	Capital Costs (1990 \$)	Description
Takoma Park, MD	1,206	\$2	\$9,000	Capital costs cover a backhoe (20 percent use) and exclude a wood chipper. O&M costs cover the low-technology composting of fall leaves. Bagged leaves and grass clippings are taken to a medium-technology County composting facility and tipped at no charge.
Upper Township, NJ	884	\$12	\$1,410	Capital costs cover a chipper (10 percent use) but exclude a front-end loader, screen-all, and tub grinder used at the medium-technology County composting site. O&M costs cover tipping fees charged by the County for brush and wood waste. Leaves and grass clippings are tipped for free. The municipality does not incur any costs. No composting was done in the base year.
Wapakoneta, OH	455	NA	\$0	In the base year, the municipality rented a manure spreader to land-apply some the organic matter. This cost is included in its \$45/ton O&M cost for collection and processing.
West Linn, OR	1,552	\$31 (f)	\$70,595	Capital costs cover composting equipment, land improvements, and a tub grinder/power unit. O&M costs cover grinding wood material and windrowing and turning yard waste every 6 weeks at the medium-technology municipa site.l
West Palm Beach, FL	12,404	\$0	\$0	The City incurs no costs. Yard waste and Christmas trees are delivered to a County composting site free of charge. composting costs the County about \$20 per ton.

Key:
cy = cubic yard NA = Not Available - = Not Applicable

Notes:

- (a) Tonnage given above represents the annual tonnage composted that the costs cover in the base year, and do not necessarily represent the total amount composted by either community or composting facility.
- (b) Per ton O&M costs reflect average annual costs incurred in the base year of study.
- (c) Represents tip fee paid.
- (d) Administration costs (\$9,187) added another \$64 per ton.
- (e) City charges WMI a \$24 per ton tip fee.
- (f) Includes collection and processing of 51 tons of recyclables at drop-off site.

Table 8.8
Communities' Materials Recovery Operating & Maintenance
Costs (Recycling and Composting Combined)

Community	Collection	Processing	Subtotal Coll & Proc	Admin	Educ/Pub	Total Materials Recovery Costs
Austin, TX	\$740,000	\$80,000	\$820,000	\$75,300	\$40,400	\$935,700
Berkeley, CA	NA	NA	\$878,000	\$275,000	\$25,000	\$1,178,000
Berlin Township, NJ	\$88,900	\$22,304	\$111,204	\$3,000	\$500	\$114,704
Boulder, CO	NA	NA	\$380,948	\$45,000	\$35,000	\$460,948
Bowdoinham, ME	\$6,754	\$27,184	\$33,938	\$10,401	\$500	\$44,839
Columbia, MO	NA	\$1,040	NA	\$29,995	\$8,650	NA
Dakota County, MN	\$643,873	\$1,256,210	\$1,900,083	\$330,000	\$91,000	\$2,758,904 (a)
Fennimore, WI	\$22,650	\$28,825	\$51,475	\$700	\$500	\$52,675
King County, WA	NA	NA	\$394,925	\$135,000	\$1,414,951	\$1,944,876
La Crescent, MN	\$25,723	\$1,715	\$27,438	\$1,878	\$551	\$29,865
Lafayette, LA	NA	NA	\$294,075	\$130,000	\$60,000	\$484,075
Lincoln, NE	\$43,743	\$32,710	\$76,453	\$54,000	\$8,566	\$139,019
Lincoln Park, NJ	\$111,500	\$14,585	\$126,085	\$17,000	\$1,000	\$144,085
Mecklenburg Co., NC	NA	NA	NA	NA	NA	NA
Monroe, WI	\$61,436	\$43,638	\$105,074	\$10,203	\$0	\$115,277
Naperville, IL	\$931,013	\$459,551	\$1,390,574	\$40,000	\$9,500	\$1,440,074
Newark, NJ	\$815,159	\$80,155	\$895,314	\$208,000	\$90,000	\$1,193,314
Parkville, PA	\$71,454	\$10,073	\$81,527	\$5,470	\$742	\$87,739
Peterborough, NH	NA	NA	\$50,000	\$23,000	\$0	\$73,000
Philadelphia, PA	NA	\$244,121	NA	\$680,950	\$108,000	NA
Portland, OR	\$0	\$0	\$0	\$612,250	\$63,048	\$675,298
Providence, RI	\$857,343	\$0	\$857,343	\$85,853	\$1,950	\$945,146
San Francisco, CA	\$6,000	\$83,000	\$89,000	\$521,000	\$290,300	\$900,300
Seattle, WA	NA	NA	\$5,573,674	\$600,000	\$500,000	\$6,673,674
Sonoma County, CA	NA	NA	\$48,020	\$38,142	\$5,450	\$91,612
Takoma Park, MD	\$213,830	\$21,130	\$234,960	\$49,800	\$6,000	\$290,760
Upper Township, NJ	\$222,607	\$10,200	\$232,807	\$59,600	\$3,200	\$295,607
Wapakoneta, OH	NA	NA	\$28,600	NA	NA	\$28,600
West Linn, OR	NA	NA	\$49,464	\$60,000	(b)	\$109,464
West Palm Beach, FL	\$997,732	\$0	\$997,732	\$104,133	\$0	\$1,101,865

Key:

Admin = Administration
 Coll = Collection

Educ = Education
 NA = Not Available

O&M = Operating and Maintenance
 Proc = Processing

Pub = Publicity
 -- = Not Applicable

Notes:

See Tables 8.4-8.7 for descriptions of what costs cover and what costs exclude. Figures in this table are based on those provided in Tables 8.9 and 8.10. For more detailed information on what costs cover see, "In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results" (Washington, DC: ILSR, 1992).

(a) Total materials recovery cost includes \$437,821 paid to municipalities for recycling activities.

(b) Education and publicity cost are included in administration costs.

Table 8.9
Communities' Recycling Operating & Maintenance Costs

Community	Year Data Collected	Collection	Processing	Coll & Proc	Admin	Educ/Pub	Subtotal
Austin, TX	FY89	\$735,000	\$0	\$735,000	\$65,300	\$30,400	\$830,700
Berkeley, CA	FY91	NA	NA	\$700,000	\$275,000 (a)	\$25,000 (a)	\$1,000,000
Berlin Township, NJ	1990	\$72,684	\$17,500	\$90,184	NA	NA	\$90,184
Boulder, CO	1990	\$235,000	\$25,000	\$260,000	\$45,000	\$35,000	\$340,000
Bowdoinham, ME	FY90	\$6,754	\$27,184	\$33,938	\$10,401	\$500	\$44,839
Columbia, MO	FY90	\$51,398	\$0 (b)	\$51,398	\$28,291	\$8,650	\$88,339
Dakota County, MN	1990	\$643,873	\$895,428	\$1,539,301	\$280,000	\$81,000	\$2,338,122 (c)
Fennimore, WI	1990	\$12,500	\$26,825	\$39,125	\$700	\$500	\$40,325
King County, WA	1990	NA	NA	\$200,000	NA	NA	NA
La Crescent, MN	1990	\$25,723	\$0 (d)	\$25,723	\$988	\$551	\$27,212
Lafayette, LA	FY90	NA	NA	\$95,700	\$97,500	\$50,000	\$243,200
Lincoln, NE	1990	\$10,787	\$450	\$11,237	\$39,000	\$8,833	\$57,070
Lincoln Park, NJ	1990	\$72,725	\$7,760	\$80,485	\$17,000	\$1,000	\$98,485
Mecklenburg Co., NC	1990	NA (e)	NA (f)	\$626,636	\$181,613	\$87,000	\$895,249
Monroe, WI	1989	\$33,311	\$36,138	\$69,449	\$8,328	\$0	\$77,777
Naperville, IL	1990	\$554,333	\$325,561	\$879,894	\$32,000	\$7,000	\$918,894
Newark, NJ	1989	\$744,023	\$0 (g)	\$744,023	\$188,000	\$72,000	\$1,004,023
Parkside, PA	1990	\$47,998	\$10,073	\$57,971	\$3,847	\$522	\$62,340
Peterborough, NH	1990	NA	NA	\$50,000	\$23,000	\$0	\$73,000
Philadelphia, PA	FY90	\$5,181,439	\$154,121	\$5,335,560	\$670,950 (h)	\$108,000	\$6,114,510
Portland, OR	1990	\$0	\$0	\$0	NA	NA	NA
Providence, RI	1990	\$857,343	\$0 (i)	\$857,343	\$85,853	\$1,950	\$945,146
San Francisco, CA	1990	\$0 (j)	\$0 (k)	\$0	\$434,500	\$251,620	\$686,120
Seattle, WA	1990	NA (l)	NA (l)	\$2,537,652	\$300,000	\$200,000	\$3,037,652
Sonoma County, CA	1990	NA	NA	\$48,020	NA	NA	NA
Takoma Park, MD	1990	\$122,130	\$18,430	\$140,560	\$36,800	\$5,000	\$182,360
Upper Township, NJ	1990	\$179,207	\$0 (m)	\$179,207	\$58,700	\$3,000	\$240,907
Wapakoneta, OH	9/89-8/90	NA	NA	\$8,200	\$240	\$0	\$8,440
West Linn, OR	1990	NA (n)	NA (i)	NA	\$45,000	(o)	NA
West Palm Beach, FL	4/90-3/91	\$374,641	\$0 (p)	\$374,641	\$34,133	\$0	\$408,774

Key:

NA = Not Available

Notes:

This table represents costs incurred by the local jurisdiction only. See Tables 8.4 and 8.5 for descriptions of what costs include and exclude.

(a) A small portion of these education/publicity and administration costs are spent on composting activities.

(b) The cost is incurred by Civic Recycling and is unavailable.

(c) Total materials recovery cost includes \$437,821 paid to municipalities for recycling activities.

(d) The cost is incurred by Houston County and is \$104/ton.

(e) The City of Charlotte incurred \$1,533,311 (\$98/ton) in addition to the County's costs.

(f) Mecklenburg County incurred a \$7.50/ton tipping fee for processing.

(g) REI Distributors incurred between \$490,000 and \$690,000 (about \$9/ton) for processing.

(h) These costs cover the curbside recycling program alone.

(i) The State incurs \$32/ton.

(j) Golden Gate Disposal spent \$7,512,305.

(k) The cost is incurred by the private sector and is unavailable.

(l) The City's costs include contract fees for collection and processing.

(m) Cape May County incurred gross costs of \$80 per ton for processing.

(n) West Linn Disposal spent \$153,109 to collect 1,338 tons of recyclables.

(o) Education and publicity costs are included with administrative costs.

(p) The Solid Waste Authority of Palm Beach Co. incurred \$26 per ton in 1990; this decreased to \$21 per ton when its new facility came online in 1991.

Table 8.10
Communities' Composting Operating & Maintenance Costs

Community	Year Data Collected	Collection	Processing	Coll & Proc	Admin	Educ/Pub	Subtotal
Austin, TX	FY89	\$5,000	\$80,000	\$85,000	\$10,000	\$10,000	\$105,000
Berkeley, CA	FY91	NA	NA	\$178,000	NA	NA	\$178,000
Berlin Township, NJ	1990	\$16,216	\$4,804	\$21,020	NA	NA	\$21,020
Boulder, CO	1990	NA	NA	\$120,948	\$0	\$0	\$120,948
Bowdoinham, ME	FY90	NA	NA	NA	NA	NA	NA
Columbia, MO	FY90	NA	\$1,040	NA	\$1,704	\$0	NA
Dakota County, MN	1990	\$0	\$360,782	\$360,782	\$50,000	\$10,000	\$420,782
Fennimore, WI	1990	\$10,150	\$2,200	\$12,350	\$0	\$0	\$12,350
King County, WA	1990	\$144,350	\$50,575	\$194,925	NA	NA	NA
La Cresent, MN	1990	\$0	\$1,715	\$1,715	\$938	\$0	\$2,653
Lafayette, LA	FY90	\$160,875	\$37,500	\$198,375	\$32,500	\$10,000	\$240,875
Lincoln, NE	1990	\$32,958	\$32,260	\$65,216	\$15,000	\$1,733	\$81,949
Lincoln Park, NJ	1990	\$38,775	\$6,825	\$45,600	\$0	\$0	\$45,600
Mecklenburg Co., NC	1990	NA	NA	NA	NA	NA	NA
Monroe, WI	1989	\$28,125	\$7,500	\$35,625	\$1,875	\$0	\$37,500
Naperville, IL	1990	\$376,680	\$134,000	\$510,680	\$8,000	\$2,500	\$521,180
Newark, NJ	1989	\$71,136	\$80,155	\$151,291	\$20,000	\$18,000	\$189,291
Parkville, PA	1990	\$23,556	\$0	\$23,556	\$1,623	\$220	\$25,399
Peterborough, NH	1990	--	--	--	--	--	--
Philadelphia, PA	FY90	NA	\$90,000	NA	\$10,000	\$0	NA
Portland, OR	1990	\$0	\$0	\$0	NA	NA	NA
Providence, RI	1990	--	--	--	--	--	--
San Francisco, CA	1990	\$6,000	\$83,000	\$89,000	\$86,500	\$38,680	\$214,180
Seattle, WA	1990	NA	NA	\$3,036,022	\$300,000	\$300,000	\$3,636,022
Sonoma County, CA	1990	NA	NA	NA	NA	NA	NA
Takoma Park, MD	1990	\$91,700	\$2,700	\$94,400	\$13,000	\$1,000	\$108,400
Upper Township, NJ	1990	\$43,400	\$10,200	\$53,600	\$900	\$200	\$54,700
Wapakoneta, OH	9/89-8/90	NA	NA	\$20,400	NA	\$0	\$20,400
West Linn, OR	1990	NA	NA	NA	\$15,000	(a)	NA
West Palm Beach, FL	4/90-3/91	\$623,091	\$0	\$623,091	\$70,000	\$0	\$693,091

Key:

Admin = Administration
NA = Not Available

Coll = Collection
Proc = Processing

Educ = Education
Pub = Publicity

-- = Not Applicable

Note:

See Tables 8.6 and 8.7 for descriptions of what costs include and exclude.

(a) Education and publicity costs are included under administrative costs.

Table 8.11
Communities' Combined Per Ton O&M Costs for Recycling and Composting

Community	Collection	Processing	Subtotal Coll & Proc	Admin	Educ/Pub	Total Materials Recovery		Net
						Gross	Revenue (a)	
Austin, TX	\$81	\$9	\$90	\$8	\$4	\$103	\$24	\$79
Berkeley, CA	NA	NA	\$69	\$15	\$1	\$93	\$0	\$93
Berlin Township, NJ	\$22	\$6	\$28	\$1	\$0	\$28	\$2	\$26
Boulder, CO	NA	NA	\$55	\$7	\$5	\$67	\$0	\$67
Bowdoinham, ME	\$23	\$124	\$118	\$36	\$2	\$156	\$10	\$146
Columbia, MO	NA	NA	NA	\$27	\$8	NA	\$7	NA
Dakota County, MN	NA	\$57	NA	NA	NA	NA	\$11	NA
Fennimore, WI	\$46	\$59	\$105	\$1	\$1	\$107	\$15	\$92
King County, WA	NA	NA	\$99	NA	NA	NA	\$0	NA
La Crescent, MN	\$88	\$5	\$73	\$5	\$1	\$79	\$0	\$79
Lafayette, LA	NA	NA	\$63	\$28	\$13	\$104	\$0	\$104
Lincoln, NE	\$16	\$12	\$28	\$20	\$3	\$50	\$1	\$49
Lincoln Park, NJ	\$29	\$4	\$33	\$4	\$0	\$37	\$3	\$35
Mecklenburg Co., NC	NA	NA	NA	NA	NA	NA	\$13	NA
Monroe, WI	\$50	\$36	\$86	\$8	\$0	\$94	\$23	\$72
Naperville, IL	\$74	\$37	\$111	\$3	\$1	\$115	\$0	\$115
Newark, NJ	\$57	\$6	\$63	\$15	\$6	\$84	\$4	\$80
Parkville, PA	\$44	\$6	\$50	\$3	\$0	\$54	\$6	\$48
Peterborough, NH	NA	NA	\$45	\$21	\$0	\$66	\$18	\$48
Philadelphia, PA	NA	\$5	NA	\$14	\$2	NA	\$1	NA
Portland, OR	\$0	\$0	\$0	NA	NA	NA	\$0	NA
Providence, RI	\$105	\$0	\$105	\$11	\$0	\$116	\$0	\$116
San Francisco, CA	NA	NA	NA	NA	NA	NA	\$0	NA
Seattle, WA	NA	NA	\$54	\$6	\$5	\$64	\$0	\$64
Sonoma County, CA	NA	NA	\$12	\$9	\$1	\$22	\$0	\$22
Takoma Park, MD	\$86	\$9	\$95	\$20	\$2	\$117	\$0	\$117
Upper Township, NJ	\$65	\$3	\$68	\$17	\$1	\$87	\$0	\$87
Wapakoneta, OH	NA	NA	\$21	NA	NA	\$21	\$0	\$21
West Linn, OR	NA	NA	\$31	\$20 (b)	(b)	\$51	\$0	\$51
West Palm Beach, FL	\$52	\$0	\$52	\$5	\$0	\$57	\$0	\$57

Key:

Admin = Administration

Educ = Education

O&M = Operating and Maintenance

Pub = Publicity

Coll = Collection

NA = Not Available

Proc = Processing

-- = Not Applicable

Notes:

Per ton costs reflect average annual operating costs in the base year of the study.

Some costs do not add up because tonnage collected, processed, and the tonnage administration and education/publicity costs cover may differ from the tonnage processed. For per ton costs for recycling collection and processing, see Tables 8.4 and 8.5.

(a) Represents revenue received by community from the sale of recyclable or compostable materials divided by the total tonnage of material recovered through publicly sponsored programs.

(b) The administration cost for West Linn includes education and publicity.

Table 8.12
Combined Per Ton Recycling and Composting Costs
(Annualized Capital and O&M)

Community	Capital	Recycling O&M	Gross	Capital	Composting O&M	Gross	Capital	Total Materials Recovery O&M	Gross	Revenue	Net
Austin, TX	\$12	\$108	\$120	NA	\$77	NA	NA	\$103	NA	\$24	NA
Berkeley, CA	\$12	\$89	\$102	\$0	\$119	\$119	\$11	\$93	\$104	\$0	\$104
Berlin Township, NJ	\$8	\$53	\$61	\$2	\$9	\$11	\$5	\$28	\$33	\$2	\$31
Boulder, CO	\$5	\$73	\$79	\$7	\$54	\$61	\$6	\$67	\$73	\$0	\$73
Bowdoinham, ME	\$7	\$156	\$163	\$0	NA	NA	\$7	\$156	\$163	\$10	\$153
Columbia, MO	\$2	\$84	\$86	\$0	NA	NA	NA	NA	NA	\$7	NA
Dakota County, MN	NA	NA	NA	\$0	\$38	\$38	NA	NA	NA	\$22	NA
Fannimore, WI	\$45	\$125	\$170	\$3	\$73	\$76	\$30	\$107	\$138	\$15	\$122
King County, WA	\$0	NA	NA	\$0	NA	NA	\$0	NA	NA	\$0	NA
La Crescent, MN	\$5	\$117	\$123	\$17	\$18	\$35	\$10	\$79	\$89	\$0	\$89
Lafayette, LA	\$25	\$100	\$125	\$4	\$109	\$113	\$15	\$104	\$119	\$0	\$119
Lincoln, NE	\$1	\$126	\$126	\$4	\$36	\$40	\$4	\$50	\$55	\$1	\$54
Lincoln Park, NJ	\$19	\$67	\$86	\$2	\$19	\$21	\$8	\$37	\$46	\$3	\$43
Mecklenburg Co., NC	NA	NA	NA	NA	NA	NA	NA	NA	NA	\$13	NA
Monroe, WI	\$6	\$97	\$103	\$5	\$90	\$95	\$8	\$94	\$102	\$23	\$79
Naperville, IL	\$0	\$121	\$121	\$10	\$106	\$116	\$7	\$115	\$122	\$0	\$122
Newark, NJ	\$1	\$147	\$148	\$6	\$25	\$32	\$3	\$84	\$87	\$4	\$83
Perkasie, PA	\$9	\$65	\$73	NA	\$39	NA	NA	\$54	NA	\$6	NA
Peterborough, NH	\$3	\$66	\$69	--	--	--	\$3	\$66	\$69	\$18	\$51
Philadelphia, PA	\$85	\$158	\$243	NA	NA	NA	NA	NA	NA	\$1	NA
Portland, OR	\$0	NA	NA	\$0	NA	NA	\$0	NA	NA	\$0	NA
Providence, RI	\$0	\$116	\$116	--	--	--	\$0	\$116	\$116	\$0	\$116
San Francisco, CA	\$0	NA	NA	NA	NA	NA	NA	NA	NA	\$0	NA
Seattle, WA	NA	\$56	\$56	\$0	\$73	\$73	NA	\$64	\$64	\$0	\$64
Sonoma County, CA	\$0	NA	NA	\$0	NA	NA	\$0	\$22	\$22	\$0	\$22
Takoma Park, MD	\$9	\$144	\$153	\$11	\$90	\$101	\$10	\$117	\$128	\$0	\$128
Upper Township, NJ	\$3	\$95	\$99	\$14	\$62	\$76	\$6	\$87	\$93	\$0	\$93
Wapakoneta, OH	\$1	\$9	\$10	\$6	\$45	NA	\$3	\$21	\$24	\$0	\$24
West Linn, OR	\$32	NA	NA	\$5	NA	NA	\$37	\$51	\$88	\$0	\$88
West Palm Beach, FL	\$4	\$162	\$166	NA	\$41	NA	NA	\$57	NA	\$0	NA

Key:

NA = Not Available O&M = Operating and Maintenance -- = Not Applicable

Note:

Per ton costs reflect average annual costs for the base year of study, which is typically 1990. See Table 1.1.

- (a) Private haulers under contract with the City incur all capital costs for curbside recycling. The City did purchase some equipment for its drop-off recycling site at its transfer station. Although these costs are unavailable, net costs are calculated because, according to City officials, these capital costs are accounted for in the City's O&M costs.

administration, and education/publicity. Most O&M costs vary with the amount of material recovered and labor hours spent. Some O&M costs, such as insurance fees, heating costs, and publicity costs, remain fixed despite the volume of material handled. Tables 8.8 through 8.10 present annual total gross O&M costs incurred by each jurisdiction for recycling, composting, and total materials recovery, including the costs for publicity and education programs and for program administration and overhead. These tables exclude expenditures by public agencies other than the community documented, as well as the value of any volunteer labor.³ Tables 8.4, 8.5, 8.6, 8.7, and 8.11 list per ton gross O&M costs for recycling collection and processing and for yard waste collection and composting, and indicate for each of these categories what these costs include. Total gross and net O&M costs for recycling and composting are presented in Table 8.11.⁴ (Recycling and composting costs include marketing costs, but they should also take into account revenues from the sale of materials. For comparative purposes we generally use gross costs and thus exclude the effect of higher sales prices, on average, for scrap materials on the coasts than in the Midwest. Net costs for these programs are often significantly lower when revenues are factored in.)

Table 8.12 lists total materials recovery costs (composting and recycling costs combined), including annualized capital costs and O&M. Capital costs typically comprise a small percentage of total costs. Traditionally, community recycling systems do not have large fixed investments, and, as a result, are able to respond to near-term changes in their operating environment (e.g., changes in the amount or composition of the waste stream, better processing technologies, more rigorous environmental standards). As indicated in Table 8.17, some recycling systems have recently become more capital-intensive.

We have made every effort to use a uniform methodology for documenting and assessing costs. Yet, due to the difficulty in gathering reliable and consistent cost information, the figures presented in this chapter do have some limitations. The observations made are not based on rigorous statistical data. In addition, the costs documented focus on the costs incurred by the local government or community studied. All the costs being incurred

by all the parties involved in recycling and composting are not necessarily reflected in the figures presented here. (The notes at the end of each table help clarify what costs are excluded, as do Tables 8.4 through 8.7.) While costs incurred by the private sector are not documented in this report, Table 8.16 does list gross operating costs by all the public sector parties involved in curbside recycling activities. Private sector recovery enterprises operate as businesses and cover their costs through the fees they charge and the materials revenues they receive. (If private recycling processors or composers do not charge local, county, or state governments for handling materials, these operators' costs are typically being covered by materials revenues, not by the taxpayer.) Readers interested in undertaking their own cost analysis should review the raw cost data as reported in *In-Depth Studies of Recycling and Composting Programs: Designs, Costs, Results*.

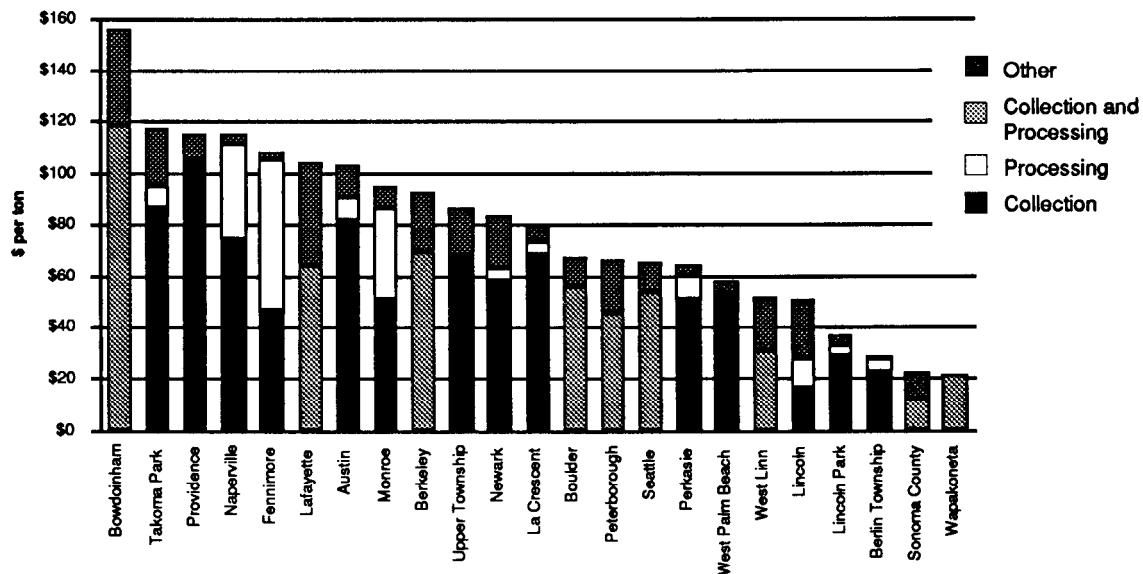
The Effect of Program Design on Costs

Tables 8.1 through 8.12 indicate that capital and O&M costs vary widely from community to community. O&M costs (excluding revenues) for recycling range from \$9 per ton in Wapakoneta to \$162 per ton in West Palm Beach. O&M costs for yard waste collection and composting range from \$9 per ton in Berlin Township to \$109 per ton in Lafayette. The capital investment made per ton-per-day recovered also varies widely. Newark has invested only \$1,420 for every ton-per-day it recycles, while Fennimore has invested \$104,400. Fennimore made the lowest investment in yard waste collection and composting equipment at \$4,800 per ton-per-day composted, while Austin made the largest at \$54,660.⁵

Why do reported materials recovery costs vary so much? How can communities avoid incurring high costs? By answering the former question, we can also address the latter.

Evaluating the economics of community materials recovery programs is a challenging task. Reliable and consistent data are often lacking. Publicly funded programs may underestimate their costs by including large volunteer efforts or excluding expenditures made by other public agencies, while private operations' data are often

Chart 8.1
Gross O&M Costs Per Ton Recovered



Notes: This chart does not include communities for which total costs were unavailable. "Other" includes administration, education, publicity, and costs that could not be broken down into the specific categories. In a few communities, costs cannot be broken down into collection and processing.

unavailable for public scrutiny. Collection and processing systems vary widely from one community to the next. Each system collects different types and amounts of materials, requires distinct set-out procedures, utilizes different vehicles and crew sizes, and employs different processing techniques. Moreover, programs differ as to service provider. Some use public crews to collect materials, others contract with private haulers for collection. While there is no simple formula for determining which system is more advantageous, this section will examine the relationships between different program types and costs.

Drop-off Versus Curbside Collection

As we discussed in Chapter 5, there are two basic strategies for collecting recyclable and compostable materials: drop-off and curbside

collection. While curbside collection is critical to maximizing participation and therefore recovery levels, drop-off is cheaper. Chart 8.1 graphs gross O&M costs per ton of material recovered. Charts 8.2a and 8.2b graph gross O&M costs for collection and processing of recyclables and compostables, respectively. In comprehensive curbside programs, collection accounts for most of the total O&M costs. The six communities whose costs in Charts 8.1 and 8.2 largely represent drop-off programs--Sonoma County, Lincoln, Lincoln Park, Peterborough, Wapakoneta, and West Linn--are those with very low per ton collection costs.⁶ While Bowdoinham is also largely a drop-off program, its expensive processing costs (\$124 per ton) elevate the total cost of the program. The small throughput at its processing facility accounts for this high per ton processing cost.

Drop-off can work as a primary collection strategy in communities in which residents self-haul

Table 8.13
Communities' Total Recycling Costs
(Annualized Capital and O&M)

	Annualized Capital Cost (\$/ton)	O&M Cost (\$/ton)	Gross Cost (\$/ton)	Revenue (\$/ton)	Net (\$/ton)	Collector	Set-out Collection Method
Seattle, WA (a)	NA	\$56	\$56	\$1	\$56	Contract	Commingled
Boulder, CO	\$5	\$73	\$79	\$0	\$79	Contract	Segregated
La Crescent, MN	\$5	\$117	\$123	\$0	\$123	Contract	Segregated
Berkeley, CA	\$12	\$89	\$102	\$0	\$102	Contract	Segregated
Providence, RI	\$0	\$116	\$116	\$0	\$116	Contract	Commingled
Naperville, IL	\$0	\$121	\$121	\$0	\$121	Contract	Segregated
Lafayette, LA	\$25	\$100	\$125	\$0	\$125	Contract	Segregated
Newark, NJ (b)	\$1	\$147	\$148	\$8	\$141	Contract/Public	Commingled
Peterborough, NH (DO)	\$3	\$66	\$69	\$18	\$51	Public	--
Berlin Township, NJ	\$8	\$53	\$61	\$5	\$57	Public	Commingled
Perkasie, PA	\$9	\$65	\$73	\$12	\$61	Public	Segregated/Comm
Monroe, WI	\$6	\$97	\$103	\$35	\$68	Public	Commingled
Lincoln Park, NJ	\$19	\$67	\$86	\$7	\$79	Public	--
Columbia, MO	\$2	\$84	\$86	\$7	\$79	Public	Segregated
Austin, TX	\$12	\$108	\$120	\$29	\$91	Public	Commingled
Upper Township, NJ	\$3	\$95	\$99	\$0	\$99	Public	Commingled
Lincoln, NE	\$1	\$126	\$126	\$0	\$126	Public/Contract	Commingled
Fennimore, WI	\$45	\$125	\$170	\$23	\$147	Public	Segregated
Bowdoinham, ME	\$7	\$156	\$163	\$13	\$150	Public	Commingled
Takoma Park, MD	\$9	\$144	\$153	\$0	\$153	Public	Commingled
West Palm Beach, FL	\$4	\$162	\$166	\$0	\$166	Public	Commingled
Philadelphia, PA	\$85	\$158	\$243	\$2	\$241	Public	Commingled

Key: DO = Primarily drop-off program O&M = Operating & Maintenance -- = Not Applicable

Notes:

(a) Private haulers under contract with the City incur all the capital costs for curbside recycling. The City did purchase some equipment for its drop-off recycling site at its transfer station. Although these latter costs are not available, net costs are calculated above because, according to City officials their costs are accounted for in the City's O&M costs.

(b) The publicly run component of Newark's curbside program was more expensive, on a per ton basis, than the contracted segment of the program.

refuse to disposal sites. In 1990 Peterborough, a small rural New England town, recycled 42 percent of its residential waste at its drop-off site, incurring an O&M cost of \$45 per ton for collection and processing (see Tables 8.4, 8.5, and 8.11).

Drop-off collection supplements curbside collection in a number of communities. By enabling residents and/or business establishments to drop off their recyclable or compostable materials throughout the week, and by accepting materials not collected at curbside, drop-off collection not only reduces total per ton program costs but also can increase the overall tonnage of material collected. In West Linn, 36 percent of the materials recovered in 1990 were collected and marketed through the City's drop-off center at an O&M cost of \$31 per ton (see Tables 8.4 and 8.11). In contrast to these costs, the City's private hauler reports incurring \$114 per ton to collect recyclable

material at curbside. Sonoma County contracts with nonprofit and for-profit recycling companies to operate drop-off sites at disposal facilities. In FY 1990 these contracts cost the County \$12 for every ton recycled (see Tables 8.4 and 8.11).

Philadelphia's Block Corner Program is another effective and inexpensive recycling system. In 1990 recyclables were collected from 10 block corner neighborhoods at an estimated cost of \$58 per ton—one-third the cost of the City's curbside program. Revenues from the material sales are returned to the community and used to fund neighborhood projects.

Service Provider: Public Versus Private

Either the public sector, the private sector, or some combination of the two can undertake collection and processing services for recyclables

Chart 8.2a
Recycling Collection and Processing O&M Costs

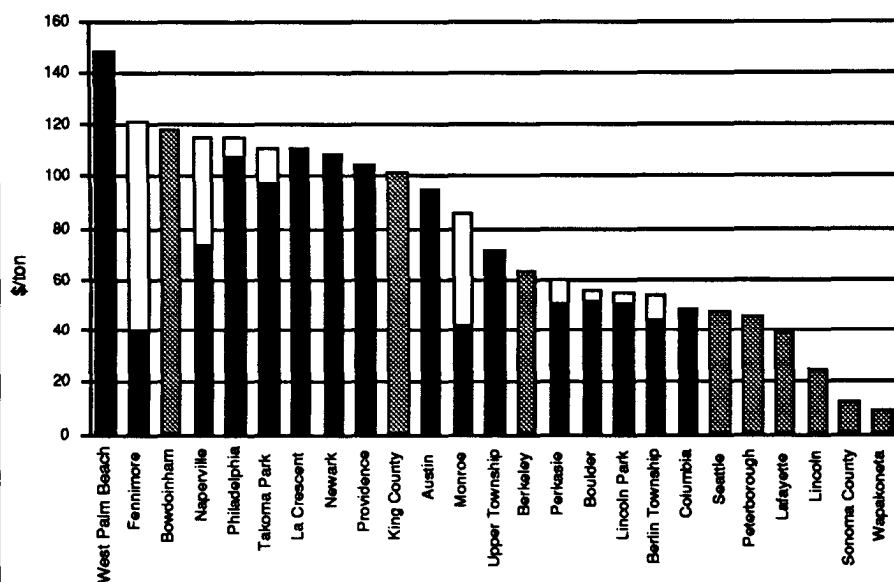
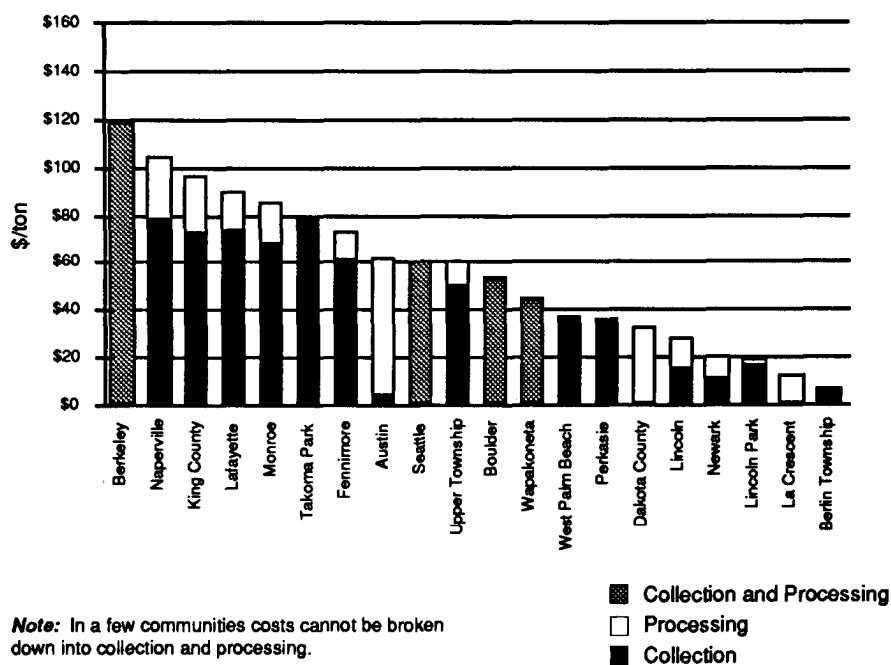


Chart 8.2b
Composting Collection and Processing O&M Costs



and yard waste. A little over one-third of our 30 communities use public crews to collect recyclables; another third contract with private haulers to provide this service; and in the remainder private haulers provide this service independent of the public sector. Arrangements for yard waste collection service vary similarly. Table 8.13 lists communities' total capital and O&M costs for recycling organized by service provider.

As Table 8.13 indicates, costs vary widely for systems with both public and contracted haulers.⁷ The net recycling costs (including collection, processing, administration, education, and annualized capital costs) of programs with contracted collection service range from \$56 per ton in Seattle to \$125 per ton in Lafayette.⁸ The City of Newark, which relies primarily on contracted service, incurred a net cost of \$141 per ton of material recycled. Communities using public collection crews incur net total costs ranging from \$57 per ton in Berlin Township, New Jersey to \$307 per ton in Philadelphia.⁹ The two least expensive programs (Wapakoneta

and Peterborough) are publicly run drop-off programs. The least expensive curbside program is Seattle's, a contract system.¹⁰ The next least expensive curbside program is Berlin Township's, a publicly run system.

There are financial advantages and disadvantages to each system. (See Table 8.14.) Communities with contracted recycling programs incur fewer capital outlays than do communities that provide service. By contracting out collection, communities also relieve themselves of the responsibility of coordinating the logistics of collection, which may lower their administrative and overhead costs. Yet contractors may pass on these costs and the cost of their equipment in the fees they charge. As listed in Table 8.11, many of the communities with the highest per ton administrative costs (over \$14 per ton) are those with publicly run systems. However, communities contracting out service usually do not receive the revenue from material sales (which may be of greater concern when secondary material prices rise). As indicated in Table 8.13, revenue earned from the sale of materials can substantially lower the per ton costs of publicly run materials recovery programs.

There is some difference between public and private service providers in regard to crew size.

Within our 30 communities, the average crew size per collection vehicle is 2.4 people for public collection programs and 1.8 people for private collection. In some cases larger crews increase costs, but in other cases they do not. Although labor costs do make up a large portion of O&M costs, total labor costs depend not on the number of crew members per vehicle but on total labor hours required. Larger crews may get the job done more quickly. For instance, the Naperville Area Recycling Center switched from two- to three-

Table 8.14
Advantages and Disadvantages of
Public and Private Service Providers

	Public	Private/Contracted
Collection	Municipalities directly control the number and types of materials targeted.	Municipalities can control the number and types of materials targeted through contracts. However, if contracts are not up for renegotiation, municipalities may not have this flexibility. Municipalities do not need to oversee the logistics of collection, which will reduce administrative overhead.
Processing	Municipalities incur costs of processing and are responsible for finding markets, unless counties or state agencies provide this service.	Municipalities do not need to oversee the logistics of processing, which minimizes administrative overhead. Municipalities often pay no costs for delivering materials to private processing centers. They may have to pay a tipping fee or they may even be paid revenue.
Marketing	Municipalities retain direct control of the materials and how these are marketed. Municipalities retain control of the materials revenue.	Municipalities may have less control over the choice of end markets. (Contracts may stipulate market preferences.) Municipalities avoid the responsibility of securing markets thus avoiding the potential need to store materials until markets open up. Relying on private processors/contractors can ease the effect of market fluctuations on smaller communities' budget.
Efficiency	Municipal employees may not be as efficient due to lack of profit incentive. (Time incentives may alter this.)	Private sector may provide more efficient services due to profit incentive.
Labor	Public crews tend to be larger than private crews.	Private crews tend to be smaller than public crews.
Financing	Municipalities may have better access to more capital to purchase equipment.	Municipalities do not need to incur capital costs for equipment. However, contractors may pass these costs on in the fees they charge.
Other	Communities may have the opportunity and ability to more fully integrate recycling programs into their solid waste management system rather than having recycling as an add-on cost to the system.	Communities can negotiate flexibility into their contracts. Community-based recycling businesses provide benefits to the community beyond recycling collection and processing services.

person crews to speed curbside collection of materials and to minimize overtime pay. The City of Philadelphia, which has the highest reported per ton O&M curbside collection cost in our sample, utilizes three crew members per vehicle. The City asserts that reducing crew size would not increase route efficiency. (Due to the high population density of Philadelphia, the City claims that recyclables are loaded more rapidly when the driver remains on board and two additional crew members follow behind to load materials.) The City does agree that reducing crew size from three to two in less dense regions, which represent approximately 10 to 20 percent of the City, would lower costs. In addition, the City is working to increase the operating efficiency of its crews.

Whether collection is private or public, municipalities have the opportunity to restructure their overall solid waste management system by shifting crews or vehicles from refuse collection to materials recovery or by encouraging their contractors to do so. Flexible contracts that allow restructuring are more attractive than fixed contracts, which do not allow the community to shift personnel and equipment to other tasks. Perkasié, Pennsylvania and Takoma Park, Maryland replaced their second weekly trash collection day with recycling collection, using the same municipal crews to collect trash and recyclables. In an effort to encourage integration of recycling and refuse collection, Newark has requested that its new contracted hauler, servicing one-third of the City, collect both refuse and recyclables.

Segregated Versus Commingled Collection and Processing

Curbside set-out and collection methods vary widely from community to community. (See Table 5.6 in Chapter 5.) Communities design their set-out and collection methods to fit existing or planned processing systems, which in turn are designed to meet the material specifications stipulated by end users. Overall O&M and capital costs depend on both collection and processing strategies. There are trade-offs between capital investments and operating costs, and between collection costs and processing costs. A community may have an expensive collection system but an inexpensive processing system, which may translate

to an inexpensive recycling program overall, or vice versa. For example, a collection system in which materials are sorted en route may obviate the need for a processing facility or may only require one with minimal processing equipment. Expensive equipment may reduce labor requirements and thus operating costs. However, the higher the capital costs, the larger the debt a community generally has to assume.

The reject rate, which results primarily from excessive glass breakage, at high-technology facilities can have a direct effect on recovery rates and costs.

The number and types of materials targeted for collection, the type of processing system available, market specifications for sale of the material, and level of service desired (customer convenience), often dictate the nature of set-out and collection. Over one-third of the 27 communities with curbside collection programs utilize some form of segregated set-out, with the number of sorts varying from three to eight.¹¹ (In this report, segregated systems are defined as those in which residents are requested to separate their glass from their metal food and beverage containers.) In other programs, residents are allowed to commingle at least some materials, which are sorted either en route (partially or completely) or at processing facilities.

Co-collection systems, in which source-separated materials are collected at the same time and with the same vehicle as refuse, may offer communities the opportunity to reduce recycling collection costs by eliminating the need for separate recycling vehicles, crews, and routes. A number of communities have tried these systems with mixed results. (See side bar, p. 138.) A promising type of co-collection is the “wet/dry” system—which has demonstrated potential to achieve high diversion rates. In wet/dry systems, dry recyclables are segregated at set-out from wet organic and compostable materials; these are segregated from any remaining refuse, and all three are collected either in the same vehicle or in different vehicles. See Chapter 5 and Appendix E for further discussion on wet/dry collection.

Table 8.15
Advantages and Disadvantages Between Commingled and Segregated Set-Out and Collection Systems

	Commingled	Segregated
O&M Cost	The O&M cost to collect commingled recyclables may be less since there are usually only two different containers or bags to pick up, but processing costs may be higher. Collection costs will increase if processing center is located far away.	The O&M cost may be more due to the slower speed of collection since there can be many different containers or bags to pick up, but processing costs may be lower or avoided altogether.
Capital Cost	The capital cost for collection may be less because specialized recycling vehicles are not needed. Processing facilities may be more expensive to build since more sorting equipment may be needed.	Capital cost for collection may be higher if specialized recycling vehicles or several different vehicles are used. Processing facilities will not need as much sorting equipment.
Reject Rate	Materials entering the processing facility are rejected (average 7 percent with a range of 0.5-16 percent).	Segregated materials entering the processing facility have a lower reject rate (average 1.2 percent with a range of 0-4 percent).
Revenue	Materials may be more contaminated resulting in a lower market value.	Materials may be higher quality and have a higher market value.
Labor	Less labor is required for collection. More time is needed for crew to load recyclables into collection vehicle.	More labor may be needed for processing. Less labor may be needed for processing.

Of our 30 communities, two--Bowdoinham and Lincoln--have used co-collection. In the small rural town of Bowdoinham, a private hauler collects clear bags of recyclables and clear bags of refuse in a pick-up truck. In Lincoln two private haulers retrofitted their packer trucks with bins for collecting aluminum and newspapers. As the private sector operates both these programs, costs are not available.

The other 25 communities with curbside collection systems collect either commingled or segregated recyclables using dedicated recycling vehicles. Communities within our sample that utilize segregated collection systems are primarily suburban or rural. In Naperville, Columbia, Portland, and West Linn, residents set out their recyclables completely segregated, and even color-

sort glass. In Fennimore and La Crescent, collection crews color-sort glass. The programs in Berkeley, Boulder, and Perkasié can also be considered segregated collection systems. The majority of the communities in this study, including many of the largest cities such as Providence, San Francisco, Charlotte (Mecklenburg County), Philadelphia, and Seattle, utilize commingled collection systems. The propensity of larger communities to select commingled systems may be attributed to the desire to speed collection; the desire to increase program participation through convenient set-out methods; the ability to support large, capital intensive processing centers to sort recyclables; and the ability to realize low operating costs as a result of the economies of scale of these centers.

There are advantages and disadvantages to both commingled and more segregated set-out and collection methods, as outlined in Table 8.15. Commingled systems allow crews to collect materials faster than segregated systems. Greater collection efficiency translates into lower collection costs. (It also might mean less capital cost investment in collection equipment because communities might be able to use existing collection vehicles and need fewer trucks.) Processing costs may be higher than those incurred by more segregated systems, and depend on scale of processing facility and equipment and labor requirements. If commingled materials are sorted at a central sorting facility, the community may benefit from low operating costs that economies of scale provide. Systems with highly segregated set-out and those that require workers to do additional sorting on the collection route can be expected to have higher collection costs due to the increased time needed to load the different materials. This higher collection cost may be offset by lower processing costs and lower materials reject rates, which lead to lower disposal costs. (The costs of collection in Fennimore and Columbia, however, indicate that segregated collection systems do not necessarily have high costs. Operating and maintenance costs for collection in these communities, where public crews color-sort glass en route, are \$39 and \$49 per ton, respectively.)

Table 8.16 lists per ton O&M collection and processing costs incurred by the public sector including the community itself, the County, and the State if applicable. (As mentioned earlier, previous tables list only communities' direct costs.) Costs vary widely. The gross operating costs of segregated curbside systems, including collection and processing, range from a low of \$39 per ton in Lafayette to a high of \$215 per ton in La Crescent. Of the communities with commingled systems, Berlin Township has the lowest O&M collection cost at \$42 per ton (\$58 per ton including processing). Philadelphia has the highest at \$173 per ton (\$181 per ton including processing), and West Palm Beach has the second highest at \$148 per ton (\$169 per ton including processing).

Because our sample of 30 communities consists of very different programs across the country, we cannot effectively compare costs among them to determine whether commingled or segregated

systems are more cost-effective. Other variables--amount of materials collected per household, tons per day collected and processed, labor costs, and basis of contract fees--may have a more significant impact on operating costs than actual set-out, collection, and processing methods. For example, Philadelphia's and West Palm Beach's high collection costs may have something to do with the fact that both programs collect less than 6 pounds of recyclable material per serviced household per week. Berlin Township, on the other hand, which has a low collection cost, collects nearly 20 pounds per serviced household. Both Lafayette and La Crescent contract out recycling collection service, and thus these costs may not be representative of the actual operating expenses of the programs.¹² La Crescent's high program costs can be attributed to factors other than set-out and collection system. These include the long distances (up to 40 miles each way) that its contracted hauler must travel to unload materials at the County processing center, the relatively small amount of recyclables collected per household, and the fact that payment to the City's recycling hauler (which is also the City's refuse hauler) is tied to the number of refuse bags sold in the City, which may diminish the company's incentive to increase the amount of recyclables collected.

Nevertheless, by looking at some individual programs and processing facilities we can illustrate some of the strengths and weaknesses of commingled and more segregated systems.

Most of the facilities accepting segregated materials have lower capital costs than those accepting commingled materials (see Table 8.17). The high-technology 240 ton-per-day CRInc facility--which processes commingled recyclables--in Montgomery County, Maryland cost \$8.5 million to construct. In contrast, the 72 ton-per-day medium-technology processing center, which is owned and operated by Eco-Cycle in Boulder and processes segregated recyclables, cost \$687,500 (1990 dollars) to build and equip--one third the cost per ton-per-day of installed capacity. The two processing facilities in Seattle provide a striking comparison of the cost difference between high-technology systems and low- and medium-technology systems. The hauler serving Seattle's north section delivers semi-segregated recyclables to the 300 ton-per-day Recycle America Processing

Table 8.16
Public Sector Curbside Recycling Collection and Processing Gross O&M Costs

	Lbs. Per Serviced Household Per Week	Per Ton Collection Cost	Public/ Private Collection	Contract Arrangement (a)	Number of Crew Members	Per Ton Processing Cost	Public or Private Facility (b)	Per Ton Collection & Processing Cost	Per Household Collection & Processing Cost Per Year	Commingled Collection System
Austin, TX	2.6	\$98	Public	--	2	\$0 (c)	Private	\$98	\$7	Yes
Berkeley, CA	5.8	NA	Contract	flat fee	1-2	NA	Private	\$67	\$10	No
Berlin Township, NJ	20.9	\$42	Public	--	1	\$16 (d)	Pub/Pri	\$58	\$30	Yes
Boulder, CO	7.0	\$61	Contract	flat fee, per HH (e)	2	\$5 (f)	Private	\$56	\$10	No
Columbia, MO	5.7	\$49	Public	--	2	\$0 (c)	Private	\$49	\$7	No
Dakota County, MN	NA	NA	Private	--	Varies	\$81	Pub/Pri	NA	NA	No
Fennimore, WI	6.4	\$39 (g)	Public	--	2	\$83	Public	\$122	\$20	No
La Crescent, MN	5.7	\$111	Contract	per refuse bag sold	3	\$104 (h)	Public	\$215	\$32	No
Lafayette, LA	3.4	NA	Contract	per HH	3	NA	Private	\$39 (i)	\$3	No
Lincoln, NE	1.9	\$33	Contract	NA	1	\$15	Private	\$48	\$2	Yes
Mecklenburg Co., NC	6.1	\$96 (j)	Public	--	1	\$8	Private	\$104	\$16	Yes
Monroe, WI	5.3	\$41 (g)	Public	--	2	\$45	Public	\$86	\$12	Yes
Naperville, IL	12.0	\$73	Contract	flat fee	3	\$43	Private	\$116	\$36	No
Newark, NJ	2.2	\$140	Public/Contract (k)	--	3	\$0 (c)	Private	\$140	\$8	Yes
Parkside, PA	9.5 (l)	\$50 (g)	Public	--	2-4	\$10	Public	\$60	\$17	Varies
Philadelphia, PA	5.8	\$173 (m)	Public	--	3	\$8 (n)	Private	\$181	\$21	Yes
Providence, RI	5.6	\$105	Contract	flat fee, per HH	1	\$32 (o)	Pub/Pri	\$137	\$20	Yes
San Francisco, CA	6.9	\$0	Private	--	1	\$0	Private	\$0	NA	Yes
Seattle (North), WA	15.8	NA	Contract	per ton	1	NA	Private	\$52 (p)	\$19	Yes
Seattle (South), WA	13.1	NA	Contract	per ton	1	NA	Private	\$57 (p)	\$15	Yes
Sonoma County, CA	8.8	\$0	Private	--	1	\$0	Private	\$0	NA	Yes
Takoma Park, MD	11.9	\$97	Public	--	3	\$14 (q)	Private	\$111	\$34	Yes
Upper Township, NJ	NA (r)	\$71 (g)	Public	--	3	\$80 (s)	Pub/Pri	\$151	NA	Yes
West Linn, OR	7.7	\$0	Private	--	3	\$0	Private	\$0 (t)	\$23	No
West Palm Beach, FL	5.3	\$148	Public	--	1	\$21 (u)	Pub/Pri	\$169	\$23	Yes

Key:

HH = Household NA = Not Available -- = Not Applicable

Notes:

Above costs are the per ton gross O&M curbside collection and processing costs incurred by the public sector, including the community itself, the County, or the State. These costs exclude any revenue received from sale of materials.

(a) Contract arrangement: "Flat fee" indicates that the contracted curbside hauler is paid a flat yearly fee for service. "Per ton" or "per household" indicates that the contracted service provider is paid on the specified basis only.

(b) Pub/Pri indicates publicly owned and privately operated facilities.

(c) Austin delivers recyclables to a private processing facility and no tipping fee is incurred. Columbia's and Newark's materials are privately processed and the City incurs no cost.

(d) Processing cost represents Township's cost to market its waste paper and the County's cost to process the Township's food and beverage containers. This latter cost was reported as \$25 per ton in 1990 in "1992-93 Materials Recovery a

(e) Boulder paid Western Disposal a flat fee to service a certain number of households and a per household fee for the households above that number.

(f) The City pays Eco-Cycle \$5 per ton processed. (Eco-Cycle's 1990 gross O&M cost was \$37 per ton.)

(g) Cost includes some drop-off collection.

(h) Houston County incurred this cost.

(i) This cost represents contract fees the City paid to The Recycling Foundation in FY 1990. Contract fees increased in FY 1991.

(j) The City of Charlotte incurred this cost, which is based on 6-month cost data.

(k) The City collected materials from one-third of Newark for 6 months and contracted with two different groups to collect the remainder.

(l) Includes materials collected from 15 small businesses and the drop-off site.

(m) Cost excludes the compensation paid to farmers to collect food waste. If included, per ton collection cost would drop to \$107.

(n) The City paid \$30 per ton at the Philadelphia Transfer and Recycling Center and received \$5 per ton at The Forge.

(o) The State incurs this cost.

(p) Seattle renegotiated its contract. In 1993 the City will pay one hauler \$78 per ton and the other \$84 per ton for both collecting and processing recyclables.

(q) Cost largely represents City's fees to private hauler to market materials collected at curbside and at drop-offs.

(r) The Township also collects recyclables from businesses; lbs./household is not available.

(s) Cape May County incurs this cost.

(t) West Linn Disposal, the City's private hauler, incurs \$114 per ton for collecting and processing recyclables.

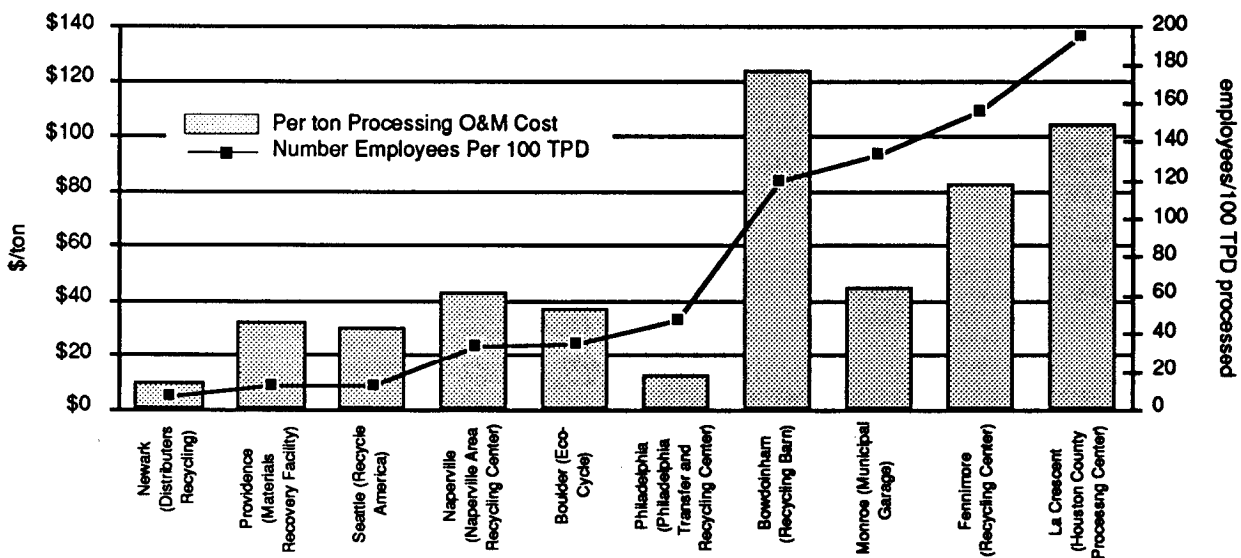
(u) The Solid Waste Authority of Palm Beach County incurs this cost, which represents processing costs at its new facility built after the base year of study.

Center, which cost an estimated \$500,000. Since recyclables are partially separated by the generators and are collected in compartmentalized trucks, the facility is used primarily for baling and for sorting commingled bottles and cans. In contrast, the Rabanco Recycling Center, to which the hauler serving Seattle's south section brings fully commingled recyclables, is a 500 to 700 ton-per-day facility that cost between \$6 million and \$8 million. This facility uses a combination of conveyors, trommel, disc screens, magnetic separation, air classification, hand picking, and baling. The Rabanco Recycling Center cost almost seven times as much as the Recycle America Processing Center on a ton-per-day of installed capacity basis.

On the other hand, because of the low throughput of many of the facilities processing segregated recyclables, these systems often have higher capital costs per ton-per-day of installed capacity than the typically larger commingled facilities. Fennimore, for example, which has relatively low collection costs, has relatively high processing costs at \$83 per ton. Two factors contribute to Fennimore's high per ton operating

costs: only 1.62 tons per day are processed, and the City's crews must travel 42 miles to market glass and metals. In addition, processing facilities with small tonnage throughputs, such as those utilized by Bowdoinham, Fennimore, and Monroe, have much higher per ton O&M processing costs than larger facilities (such as those in Seattle, Providence, or Montgomery County). The amount of manual labor used at small facilities is one reason for their higher per ton cost. Bowdoinham employs two workers at its 2 ton-per-day facility (or 120 employees per 100 tons per day processed). Large facilities can process on the order of several hundred tons per day with high-technology equipment and relatively few employees. For example, the Montgomery County facility employs 9 workers per 100 tons per day processed; the Rhode Island facility utilizes 12.5 employees per 100 tons per day processed. Chart 8.3 shows the relationship between the number of employees per 100 tons per day processed and the O&M processing cost. As the number of employees per ton-per-day processed increases, so does the O&M cost.

Chart 8.3
Processing Facility O&M Costs and Labor Requirements



Note: Costs represent the actual operating and maintenance expenses of the listed facility and are not necessarily incurred by the documented communities. Some communities are excluded because either their O&M costs or the number of employees per 100 tons per day were not available.

Table 8.17

Costs and Characteristics of Intermediate Processing Facilities

Community	Facility Name	Distance to IPC (miles)	Regional Facility	Days Per Year In Operation	Design Capacity (TPD)	Throughput (TPD)	Daily Tonnage Delivered By Community	Capital Cost (1990\$) (a)	Capital Cost (\$/TPD of capacity) (b)
SEGREGATED									
Berkeley, CA	SWMC	L	No	NA	75	50	NA	\$370,400	\$4,900
Boulder, CO	Eco-Cycle	L	Yes	254	NA	72	25	\$687,500	\$8,500
Columbia, MO	Civic Recycling	5/L	No	260	100	75	5.8	NA	NA
Dakota County, MN	RCC	—	No	307	20	40	—	\$238,100	\$11,900
Fennimore, WI	Recycle Center	1/L	No	200	NA	1.6	1.6	\$94,700	\$58,800
La Crescent, MN	Houston County IPC	10-40	Yes	235	5	2.6	1.3	\$269,700	\$53,900
Lafayette, LA	Recycling Foundation IPC	0-15	No	305	30	20	8	NA	NA
Naperville, IL	NAPRC	10/L	Yes	NA	50	35-70	NA	\$75,000	\$1,500
Perkasie, PA	Public Works Yard	0-15/L	No	—	NA	3	—	\$51,700	\$16,200
Portland, West Linn, OR	K.B. Recycling	32,242	Yes	312	NA	167	NA	\$1,500,000	\$9,000
COMMINGLED									
Austin, TX	ACCO	L	Yes	280	400	200	25	NA	NA
Austin, TX	Ecology Action	L	Yes	250	21	11	NA	NA	NA
Berlin Township, NJ	CCRF	10	Yes	250	80	72	1.5	\$781,400	\$9,800
Bowdoinham, ME	Recycling Barn	1	No	156	NA	1.4	1.4	\$16,400	\$11,700
Mecklenburg Co, NC	FCR/Charlotte IPC	NA	Yes	255	200	80 (g)	73	\$700,000	\$3,500
Monroe, WI	Municipal Garage	1/L	No	NA	NA	3	NA	\$16,600	NA
Newark, NJ	Distributors Recycling	1-20/L	Yes	NA	NA	240	NA	\$1,250,000	\$5,200
Philadelphia, PA	PTRC	1-10/L	Yes	260	100	75	40	NA	NA
Providence, RI	MRF	15	No	260	120	190-240	31	\$6,000,000	\$25,000
San Francisco, CA	West Coast Salvage	3-5/L	Yes	NA	NA	450	3,000	NA	NA
Seattle, WA	Recycle America PC	NA/L	No	260	300	<200	NA	\$500,000	\$1,700
Seattle, WA	Rebenco Recycling Ctr.	NA/L	No	NA	600	300	NA	\$7,000,000	\$11,700
Takoma Park, MD	Georgetown Paper Stock	10	Yes	281	500	350-400	1.2	NA	NA
Takoma Park, MD	Montgomery Co. Rec. Ctr.	13	Yes	260	240	NA	NA	\$8,500,000	\$35,400
Upper Township, NJ	CMCMUA IPF	1-15/L	Yes	256	225	50-90	10	\$575,400	\$2,600
West Palm Beach, FL (k)	SWA MRF	18-51	Yes	302	250	200	8.4	\$6,300,000	\$25,200

Key:

(i) Denotes revenue received.

A = Aluminum

ACCO = ACCO Waste Paper Processing Center

B = Batteries

CCRF = Camden County Recycling Facility

CMCMUA IPF = Cape May County Intermediate

Processing Facility

F = Ferrous Cans

G = Glass

FCR = Fairfield County Recycling

HP = High-grade Paper

IPC = Intermediate Processing Center

L = Located within city limits

M = Scrap Metal

MP = Mixed Paper

MRF = Materials Recovery Facility

Notes:

"Segregated" designates IPCs that receive food and beverage containers pre-sorted into more than one stream.

"Commingled" designates IPCs that receive food and beverage containers unsorted in one stream.

Costs are not necessarily incurred by the listed jurisdiction.

(a) In Naperville, West Linn, Portland, Mecklenburg Co., Newark, Takoma Park (Montgomery Co.), Seattle (both), and Providence, capital costs of IPCs are estimates based on the year of construction and therefore are not converted into 1990 dollars.

(b) For Fennimore, Monroe, Newark, Perkasie, Portland, and West Linn capital costs \$/TPD of capacity were calculated with the TPD throughput because the design capacity is not available. The capital costs for the improvements of Naperville's facility are not included. In Providence, the MRF currently operates over two shifts; thus 240 TPD was utilized.

Table 8.17 continued

Annual O&M Cost (\$/ton)	Tip Fee (\$/ton)	Revenue Per Ton	Revenue Recipients	Materials Processed	Reject Rate (% by weight) (c)	Total Number of Employees	Number of Employees Per 100 TPD Processed	Tech- nology Type (d)
NA	\$0	\$28	Operator	A,F,G,MP,ONP	1	14	28	Medium
\$37	\$0	\$53	Operator	A,B,F,G,HP,MP,OCC,ONP	1	25	35	Medium
NA	RR (e)	NA	City/Operator	A,F,G,HP,MP,OCC,ONP,P	NA	20	27	Medium
\$68	(\$33)	\$36	Operator/County	A,F,G,OCC,ONP,P	1	NA	NA	Medium
\$83	\$0	\$23	City	A,F,G,HP,MP,OCC,ONP,P	0	3	155	Medium
\$104	\$0	\$51	County	A,B,F,G,HP,OCC,ONP,P,WG	1	5	195	Medium
NA	\$0	\$37	Operator	A,F,G,OCC,ONP,P	1	13	65	Low
\$43	\$0	NA	Operator/City	A,F,G,HP,MP,OCC,ONP,P	2-5	15-20	33	Medium
\$12	\$0	\$11	Borough/Operator	A,G,MP,OCC,ONP	0	NA	NA	Low
NA	RR	NA	Operator	A,F,G,M,MP,O,OCC,ONP,P	2	20	12	Medium
NA	(\$20)	NA	City	A,F,G,OCC,ONP	10	22	11	Medium
NA	NA	NA	Operator	A,B,F,G,HP,MP,OCC,ONP,P	NA	4	36	Medium
\$25 (f)	\$0	NA	County/City	A,F,G,P	15.6*	20	28	Medium
\$124	\$0	\$10	City	A,B,F,G,HP,M,MP,O,OCC,ONP,P,WG,X	5	2	120	Low
NA	\$8	NA	Operator/County	A,F,G,ONP,P	7	26	33	Medium
\$45	\$0	\$35	City	A,B,F,G,HP,M,MP,O,OCC,ONP,P,WG	<1	5	133 (h)	Low
\$9	(\$12)	NA	Operator	A,F,G,M	5	15	6	Medium
\$13	\$30	NA	Operator	A,F,G,ONP,P	13	35	47	Medium
\$32	\$0	\$29	Operator/State	A,F,G,ONP,P	14	27	13	High
NA	NA	NA	Operator	A,F,G,HP,MP,OCC,ONP,P,X	NA	102	23	Medium
\$30	NA	NA	Operator	A,F,G,HP,MP,OCC,ONP,P	0.5	24.5	~13	Medium
NA	NA	NA	Operator	A,F,G,HP,MP,OCC,ONP,P	2.7	16	5	High
NA	\$20 (i)	NA	Operator	A,F,G,HP,MP,ONP	10	50	13	Medium
NA	NA (j)	NA	Operator/County	A,F,G,ONP,P	7-12	24	9 (h)	High
\$80	\$0	NA	Operator/County	A,F,G,HP,MP,OCC,ONP,P	2.38*	40-85	NA	Medium
\$21	\$0	NA	Operator/County	A,F,G,OCC,ONP,P	6	18	9	High

NA = Not Available

NARC = Naperville Area Recycling Center

O = Oil

OCC = Corrugated Cardboard

ONP = Newspaper

P = Plastics

PC = Processing Center

PTRC = Philadelphia Transfer and Recycling Center

RCC = Recyclables Collection Center

RR = Revenue Received

RRT = Resource Recycling Technologies

SWA MRF = Solid Waste Authority MRF

SWMC = Solid Waste Management Center

TPD = Tons Per Day

WG = White Goods, Appliances

WMI = Waste Management Inc.

X = Other, inc. salvaged items

(c) Municipalities noted with an asterisk weigh residue; the remaining municipalities do not.

(d) Low: minimal equipment, relies heavily on manual labor. Medium: some equipment and manual labor. High: extensive equipment (elaborate conveyor systems, etc.) to sort/process commingled recyclables.

(e) In Columbia revenue is received as part of the processing tipping fee arrangement for all materials but paper.

(f) Represents 1990 O&M costs as reported in "1992-93 Materials Recovery and Recycling Yearbook" (New York: Governmental Advisory Associates, Inc., 1992)

(g) Although FCR/Charlotte processes 80 tons per day operating one shift, the facility was designed to process 200 tons per day in two daily shifts.

(h) The number of employees per 100 TPD processed is based on design capacity rather than throughput.

(i) There is a \$20 per ton processing fee arrangement for commingled recyclables.

(j) The County pays CRInc. a flat fee of \$844,000 per year for processing recyclables.

(k) Characteristics listed above are for Palm Beach County's new processing facility, which became operational in April 1991 (after the base year of study).

One way to reduce materials recovery processing costs is to deliver materials directly to market without prior processing, and/or to perform a minimal level of processing, such as color-sorting glass, on the vehicle. In Berlin Township, Dakota County, Lincoln Park, Perkasio, and Portland, some materials are delivered directly to markets without being processed. Berlin Township brings newspaper and mixed paper directly to a paper mill. Perkasio does not have a real processing facility. Collection workers separate all glass and aluminum at curbside, put them into a compartmentalized trailer, and deliver them to the public works yard, where vendors collect them. Paper is collected separately and delivered directly to markets. Because materials are sorted at the curb or on the collection vehicle, material collected through segregated systems require minimal to no processing. In fact, a number of the communities employing segregated systems, such as Naperville, Boulder, and Perkasio, incur lower O&M processing costs than collection costs. Processing costs are \$43 per ton in Naperville, \$5 per ton in Boulder, and \$10 in Perkasio.

Overall O&M and capital costs depend on both collection and processing strategies. There are trade-offs between capital investments and operating costs, and between collection costs and processing costs.

Another way to reduce processing costs is to take advantage of the economies of scale offered by centralized sorting facilities. Many of the communities utilizing commingled collection systems rely on large County- or State-run processing centers. (See Table 8.17.) Such facilities usually are capital-intensive, but have relatively low operating expenses. For example, Palm Beach County processes West Palm Beach's recyclables in its new \$6.3 million processing facility, which opened in mid-1991 and is designed to process 220 tons per day. The County pays private operators \$21 per ton to run the plant.

While large capital-intensive facilities benefit from economies of scale and thus can have lower

operating costs, the extensive machinery utilized often results in high material breakage rates.

Providence, one of the largest cities in this study, provides a useful example of the advantages and disadvantages of commingled systems. Providence pays a private hauler \$105 per ton to collect commingled recyclables, and the State spends \$32 per ton to process the material at a high-technology processing facility operated by New England CRInc. The 200 ton-per-day facility cost \$6 million. The facility receives an average of \$29 per processed ton in materials revenue (\$33 per marketed ton), half of which is for the sale of aluminum. However, over 40 percent of all glass entering the facility breaks. Broken glass is landfilled, as is other processing residue, which is estimated at 14 percent by weight of all material entering the facility. If we subtract the amount rejected at Rhode Island's processing center, Providence's per ton collection costs jump from \$105 per (collected) ton to \$119 per (marketed) ton. Operating costs for the processing facility are \$37 per ton actually marketed (\$32 per ton processed). The State of Rhode Island estimates that in 1990 it incurred \$1.3 million in disposal costs and lost revenue collecting and processing glass containers that ended up in the landfill.¹³

In commingled systems, material can break or be otherwise rendered nonmarketable during collection and processing. For example, Rhode Island reports that approximately 20 percent of all glass collected breaks en route while another 20 percent breaks during processing at its high-technology facility. Seattle also reports problems with glass breakage en route and is currently storing a large pile of mixed glass cullet in the hope that market opportunities will open in the future. (In its new recycling contract, Seattle is requiring one of its haulers, who formerly collected all materials in one stream, to color-sort glass. This is predicted to reduce problems with glass breakage as well as increase the value of paper, which sometimes had been contaminated with broken glass slivers.) Fennimore and La Crescent, on the other hand, deliver color-sorted material to their processing centers and lose next to no material; nearly all collected tonnages are marketed.

Rhode Island is examining ways to retrofit collection vehicles (which are generally Labrie sideloading, dual-compartmentalized vehicles),

including installation of an interior net or baffling. Such methods have proven successful in shortening the fall of the glass containers and providing a plastic cushion for the glass.¹⁴

Some communities with medium- and high-technology processing facilities, such as Cape May County, New Jersey, have secured markets for broken glass. Approximately 50 percent of the glass delivered to Cape May County's IPC is broken by the time it reaches the facility. The County's arrangement with the IPC's private operators requires that they pay for the disposal of residue materials if these exceed 5.5 percent of commingled glass and cans. The operators market broken glass to a local glassphalt manufacturing company. In 1990 only 2.38 percent of all material entering the facility was landfilled as residue. Glassphalt, however, is not an optimum solution to the glass breakage problem. Whereas clear glass cullet was worth \$42 per ton in 1991, a ton of mixed cullet for production of glassphalt brought in only \$0 to \$10.¹⁵

Collection and processing systems for segregated recyclables result in low breakage and reject rates. Reject rates at centers for segregated

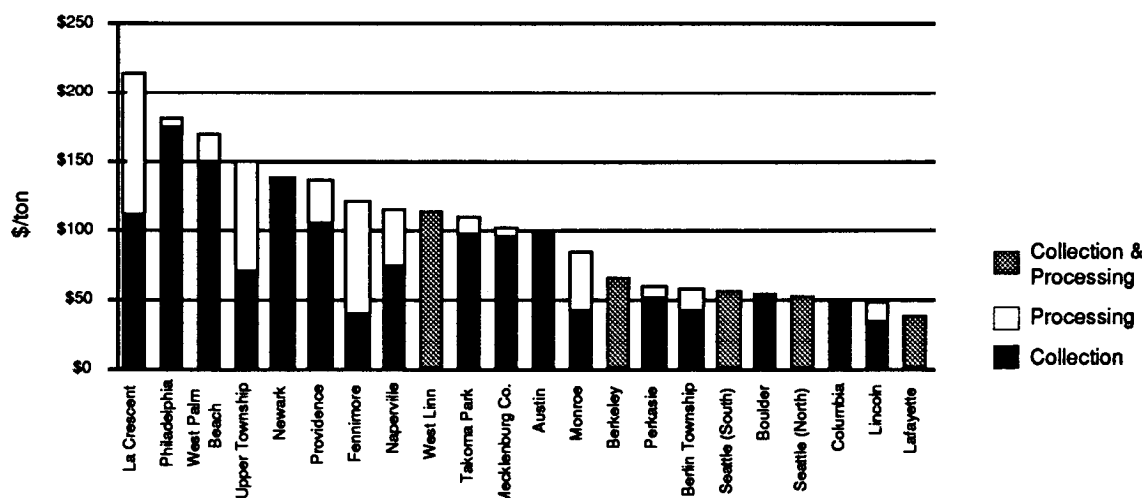
materials range from 0 to 4 percent by weight, with an average of a little above 1 percent. For commingled facilities the range is 0.5 percent to 16 percent by weight, with an average of 7 percent.

Many of the communities with segregated systems, such as Naperville, Berkeley, and Boulder, have gained a reputation of having especially high-quality materials. In some instances, end users have approached these cities to purchase materials.

The Effect of Labor on Cost

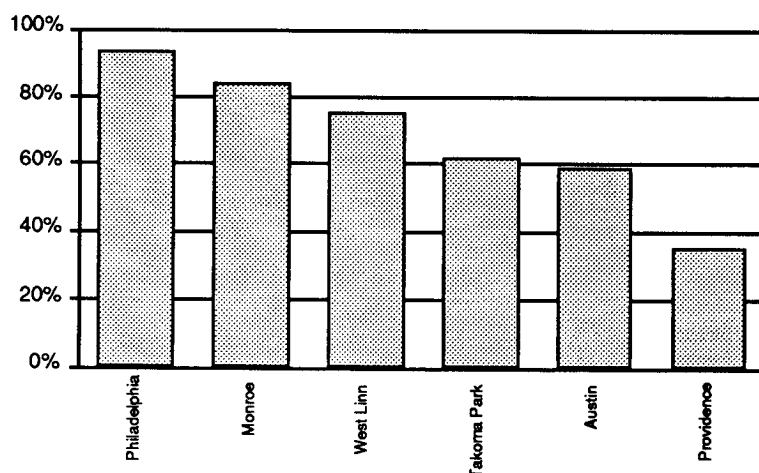
The variation in the cost of materials recovery is partially due to demographic and regional factors. The cost of living, which determines the average hourly wage paid to workers, varies greatly across the country. Household density affects the number of stops per collection route; topography and weather can influence collection efficiency as well as the number of crew members required per vehicle. Even the price of gasoline, which greatly affects transportation expenses, varies across the country. However, the same demographic factors that affect materials recovery will affect refuse collection. Among these variables,

Chart 8.4
Public Sector Curbside Recycling Collection and Processing O&M Costs



Notes: Costs represent the full public sector O&M collection and processing expenses for curbside recycling. Communities for which this information is unavailable are excluded. These costs are not always incurred by the documented community, and may represent County or State expenses. For West Linn, costs represent those incurred by the City's private hauler. Please see Table 8.16 for clarification.

Chart 8.5
Percent of Recycling Collection
O&M Cost Spent on Labor



Notes: Many communities are missing because this information is not available. Monroe's figure is labor as a percent of total costs of recyclables and yard waste collection and processing.

Labor costs have the same effect on refuse collection costs as on recycling and composting costs. In West Linn, where hourly wages are almost \$15, the private hauler spends \$114 per ton (75 percent of which goes for labor) on curbside collection of recyclables, and \$144 per ton for refuse collection and disposal. In Philadelphia, collection of recyclables costs \$173 per ton, while refuse collection and disposal cost \$170 per ton.

Regardless of hourly wage and crew size, the key to keeping down the costs of materials recovery is efficient use of labor resources. Co-collection systems are already proving to be one way to do this. (See side bar on co-collection, page 138.)

labor expenses have perhaps the most significant effect on costs.

In communities with comprehensive curbside collection programs, collection costs account for the largest portion of total operating and maintenance costs. See Chart 8.4. Labor costs in turn account for most of the costs of collection. One industry report found that 69 percent of the total outlay for residential collection consists of labor costs.¹⁶ Chart 8.5 shows labor costs as a portion of operating and maintenance costs for those communities for which this information is available. Hourly wages are often higher in large cities and their suburbs than in rural communities, or in cities in the South or Midwest. Higher wages can lead to higher collection costs. For example, Philadelphia pays its workers \$9.50 per hour; labor costs make up more than 90 percent of its \$173 per ton cost for municipal curbside collection of recyclables. In contrast, Austin pays its workers \$7 per hour; labor costs make up less than 60 percent of its \$98 per ton collection cost. Three workers operate each recycling collection vehicle in Philadelphia, while two operate the vehicles in Austin.

While keeping down the costs of materials recovery is an important goal, providing jobs is important to communities as well. Recycling and composting programs employ people in a variety of capacities in both the private and public sectors. For example, processing centers that handle between 2 and 450 tons of recyclables per day employ between 2 and 102 workers--6 to 195 workers per ton-per-day processed. (See Table 8.17.) In recycling, the largest opportunity for job creation is actually in the remanufacturing field, which offers high-paying jobs. Materials recovery also provides employment for low-skilled, handicapped, and prison workers. (See Table 8.18.)

Reducing Program Costs

Whatever program design a community selects, there are ways to make recycling and composting more successful and cost-effective. By studying and comparing the costs incurred by our 30 communities, we have found that communities can reduce their overall materials recovery costs by

- negotiating favorable conditions in contract arrangements,

Table 8.18
Communities Providing Employment Opportunities for
Low-Skilled, Handicapped, or Prison Workers

Community	Non-traditional Labor
Austin, TX	ACCO Waste Paper Processing Center employs 20 developmentally disabled people to hand sort glass. Prison inmates remove leaves from plastic bags at the composting site.
Boulder, CO	Eco-Cycle employs five developmentally disabled people to sort recyclables.
La Crescent, MN	The Houston County Processing Center employs three handicapped people to process recyclables.
Lafayette, LA	In addition to paid employees, some prison laborers are used to separate recyclables.
Monroe, WI	Disabled workers from a local shelter are employed for approximately 8 months out of the year at or below minimum wage to sort recyclables.
Newark, NJ	Several state prison inmates work at the composting site. The City also contracts with the Occupational Center (OC) to service one third of the City with curbside collection. The OC is a community-based nonprofit organization that trains and educates handicapped individuals.
Seattle, WA	The City contracts with Seadrunar Recycling, a nonprofit organization committed to drug rehabilitation of juveniles and adults, for weekly pick-up of waste paper at Municipal offices.
Sonoma County, CA	Garbage Reincarnation uses volunteers from local schools, court-referral programs, and mentally disabled to sort and prepare materials for market.
West Linn, OR	Inmates from correctional facilities occasionally work at the drop-off center.

- utilizing drop-off programs in rural areas where curbside programs may not be cost-effective, or to supplement curbside programs,
- maximizing the public's participation and the amount of tonnage recovered,
- reducing the distance and time traveling to materials recovery processing centers or markets,
- utilizing collection vehicles with appropriate capacities to avoid frequent unloading,
- collecting source-separated yard waste for composting,
- taking advantage of private sector or regional processing facilities,
- sorting material en route to increase the quality of material, reduce processing costs, and minimize material rejected,
- integrating materials recovery programs and systems into the existing solid waste management

system (rather than viewing them as add-on systems),

- utilizing appropriately designed co-collection systems, and
- making use of existing equipment.

Contracted Programs

As discussed earlier, a little less than one-third of the communities studied contract out for collection and/or processing services. The following strategies have proven effective in reducing costs and maximizing recovery levels in contracted situations

- making use of competitive bids,
- including locally-based organizations and entrepreneurs in the bidding process,
- retaining some portion of materials revenues,

- encouraging haulers to increase the amount of materials collected (e.g., by basing a contract on per ton fees), and
- negotiating refuse collection and disposal contracts that provide discounts for reduced refuse volume due to recycling or source reduction.

Competitive Bids

Communities can ensure lower contract fees through competitive bidding. Seattle has been able to maintain low recycling collection costs (\$47 per ton in 1990) due to a 5-year contract obtained through a competitive bidding process.¹⁷ Moreover, because the contracts are based on tonnage recovered, the haulers are provided with a strong incentive to maximize the material they collect. Newark's low per ton collection cost for yard waste—less than \$10—is due in part to competitive bidding for yard waste collection. Philadelphia is framing a competitive bid structure that will enable both private companies and the municipal collection crew's union and management to participate in the bidding process.

Nonprofit Organizations

Six of the 30 communities contract with nonprofit recycling organizations for some aspect of their recycling collection or processing. Because nonprofit groups do not operate with a profit margin, communities that contract with such groups may incur lower costs than they would with for-profit companies. Nonprofit organizations typically provide services that extend beyond collection and processing. For example, many engage in extensive recycling and source reduction education programs.

Nonprofit groups in Berkeley provide cost-effective recycling services. In 1990 the City of Berkeley paid the Ecology Center the equivalent of \$67 for every ton it collected and processed under its curbside recycling contract, and paid the Community Conservation Center, Inc. (CCC) \$10 per ton recycled to operate the Berkeley Buy Back Center. The City also supports the activities of these organizations by providing them equipment and land.¹⁸

Boulder has one of the lowest processing costs among our 30 communities—\$5 per ton. It contracts with Eco-Cycle, a local nonprofit organization, to provide this service. The City contracts with a private hauler to collect recyclables, but stipulates in the contract that the hauler must bring the materials it collects to Eco-Cycle for processing. The revenues from materials sales are then split between the two groups. Eco-Cycle keeps its costs down by using retrofitted equipment, and by assigning prison and community service laborers to certain processing tasks. Both Eco-Cycle (Boulder) and the Ecology Center (Berkeley) lead extensive educational programs in their cities.

Revenue Sharing

Communities can reduce the net costs of materials recovery by writing revenue-sharing agreements into recycling contracts. For instance, Urban Ore, a for-profit salvage/reuse drop-off operation in Berkeley, is required through a license agreement to pay the City 10 percent of its monthly gross revenues.¹⁹ The contract fee paid to Berkeley's nonprofit curbside collection provider, the Ecology Center, is tied to the door price of newspaper, and is designed to cover the difference between the program's cost and the revenues earned from the materials sold. The City of Naperville receives 50 percent of the profit realized by the contractor. (In 1990 no profit was earned.) Columbia receives 50 percent of the average monthly price for aluminum and glass based on figures published in *Recycling Times*, and 70 percent of the indexed price from the *Paper Stock Report* for corrugated cardboard. (In addition, the City pays the processor a \$15 per ton processing fee for newspaper.) Dakota County and Montgomery County receive some revenue from the sale of materials even though they contract with private firms to operate and maintain their processing facilities. The private operator of the facility in Montgomery County receives 25 percent of gross revenue, and the County receives 75 percent. Also, as an incentive to use local markets, the operators are responsible for 25 percent of the cost of transporting processed materials to market.

Cities can not only lower recycling costs through revenue-sharing agreements, but they can also help

ensure profitable or break-even contract arrangements for private haulers in light of highly variable market conditions. Seattle's new recycling contract stipulates that the City will share all market risk with its contractors. If prices for recyclables rise above predetermined levels, the City will receive all of the extra revenue in the form of reduced per ton payments. If prices fall, the City will cover all of the loss through higher per ton payments.

Retaining Flexibility to Reduce Refuse Costs in Refuse Contracts

Cities can retain the flexibility to shift resources between materials recovery programs and refuse collection through proper negotiating of refuse and recycling contracts. For example, when Naperville signed its last 5-year refuse collection contract, it was just beginning a pilot curbside program. A clause in the contract stipulated that after 1 year, the hauler, the recycling center, and the City would negotiate a rebate for the City from the hauler based on the volume of material diverted from the landfill by the recycling center. As a result of this clause, the City's refuse hauler gave Naperville a diversion credit of \$35 for each ton of materials recycled in 1990. This credit was based on avoided tipping fees, trips to the landfill saved, and collection time saved. The value of the latter two was calculated by estimating the reduction in labor and vehicle costs. (Listed recycling costs for Naperville do not include this \$35 per ton diversion credit.) Naperville further reduced its refuse collection costs in 1990 by eliminating one of its two weekly refuse collection days, and instead providing weekly collection of refuse, recyclables, and yard waste. In 1991 the City paid 20 percent less to collect and dispose of refuse.

Newark has requested bids for a new recycling collection contract in one-third of the City. It prefers that the future contractor pick up both recyclable and refuse from these zones so that collection infrastructure and equipment can be shared between these two functions.

Reducing Costs in Publicly-run Programs

Over one-third of the communities studied provide municipal pick-up of recyclables and/or yard waste. The following techniques have proven helpful in keeping down the costs of such programs. Some of these techniques may be applicable to privately operated programs as well.

Maximizing Participation and Tonnage Recovered

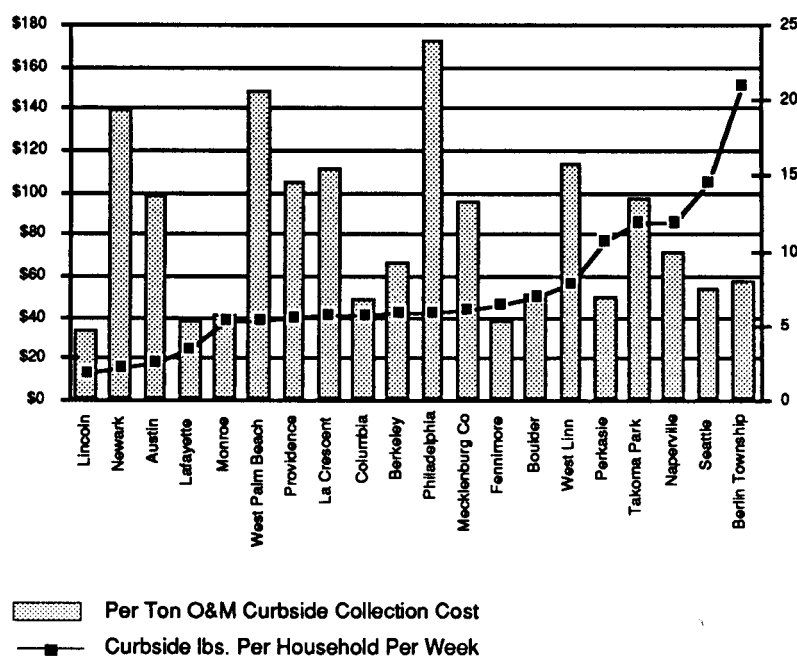
Communities that target a wide range of materials for collection (particularly items that comprise a significant percentage of the waste stream, such as residential mixed paper and yard waste), and secure the participation of all waste generators in collection programs, are able to reach waste recovery rates of 40 percent and above. (See Chapter 5.) Similarly, communities that maximize the amount of material collected, often have low per ton recycling and composting costs. A truck must travel the same route length regardless of how many residents participate in the program. Recycling collection systems become most cost-effective when the amount of material collected at each stop is maximized.

Chart 8.6 compares per ton curbside collection costs for recyclables to pounds recycled per week per household served. Although at first glance there may appear to be no direct correlation, note that six of the nine communities with costs above \$80 per ton—Austin, Newark, West Palm Beach, Providence, La Crescent, and Philadelphia—are among those that recover the lowest amount of recyclables per household—all less than 6 pounds per week. In contrast, six of the eleven programs with costs lower than \$80 per ton—Perkasie, Seattle, Naperville, Fennimore, Berlin Township, and Boulder—are recycling more than 6 pounds per week.

Austin collects relatively few materials at curbside: newspaper, corrugated cardboard, glass, aluminum, and ferrous cans. West Palm Beach, Providence, and Philadelphia collect only newspaper and food and beverage containers. These four communities are among those with the highest per ton costs. In comparison, Seattle,

Chart 8.6

O&M Collection Costs for Curbside Recycling Programs and Pounds Per Household Recycled



Notes: Berkeley's, Lafayette's, and Seattle's costs include processing. Fennimore's, Monroe's, and Perkasie's cost figures cover the collection of a small amount of drop-off materials. Mecklenburg County's costs represent the City of Charlotte's curbside collection costs.

Naperville, Fennimore, and Berlin Township collect many types of low- and high-grade paper in addition to food and beverage containers. Naperville also collects scrap metal, clean polystyrene containers, and LDPE 6-pack plastic rings. Fennimore and Berlin Township collect all types of PET and HDPE containers.

Because participation rates play a role in increasing recovery levels, they also affect per ton collection costs. Seattle, Fennimore, Berlin Township, and Perkasie, with participation rates of 83 percent, 100 percent, 97 percent, and 100 percent, respectively, all have low per ton recycling collection costs. On the other hand, Austin, Providence, and La Crescent have higher collection costs and participation rates of 40 percent, 74 percent, and 74 percent respectively.

Chart 8.7 presents similar information for yard waste collection. The three programs collecting the most yard waste per household have the lowest per ton costs. Berlin Township and West Palm Beach collect more than 11 pounds per household per week at curbside and have inexpensive collection programs (\$7 and \$37 per ton, respectively). On the other hand, Lafayette, Monroe, Fennimore, Naperville, and Takoma Park collected less than 11 pounds of yard waste per household per week and have much higher costs.

The City of Austin attributes its low per ton costs to limited yard waste service by a few of its haulers (who collect bagged leaves in their refuse packer trucks during portions of their refuse collection routes) and to the shorter distance haulers have to travel to unload yard waste as compared to refuse or recyclables. If only a few materials are collected, the costs of the existing waste handling system may not be greatly impacted. As communities collect more, they incur additional costs to collect and process recyclables and yard waste above the costs incurred for their

traditional refuse collection and handling systems. The more materials communities collect, the more these additional costs can be offset by reduced costs of managing solid waste destined for disposal, and the more costs per ton will decrease. Nevertheless, Austin's and Lincoln's low costs indicate that while the amount collected per household per week may have some correlation to cost per ton, other factors are at play (such as labor costs and set-out and collection method).

Unloading Frequency and Distance to Processing Facilities

Table 8.19 lists curbside collection cost, number of crew members per collection vehicle, number of times the truck must unload per day, truck type

and capacity, and distance to the processing center or transfer station--all of which impact curbside collection efficiency.

The distance to the processing center or transfer station and the number of times a truck must unload appear to have the most substantial impact on curbside collection costs of these variables. Traveling time costs a city money in labor expenses, fuel fees, and truck maintenance. In contrast to driving a collection route to pick up materials, traveling to unload materials is unproductive time and can be considered an add-on cost.

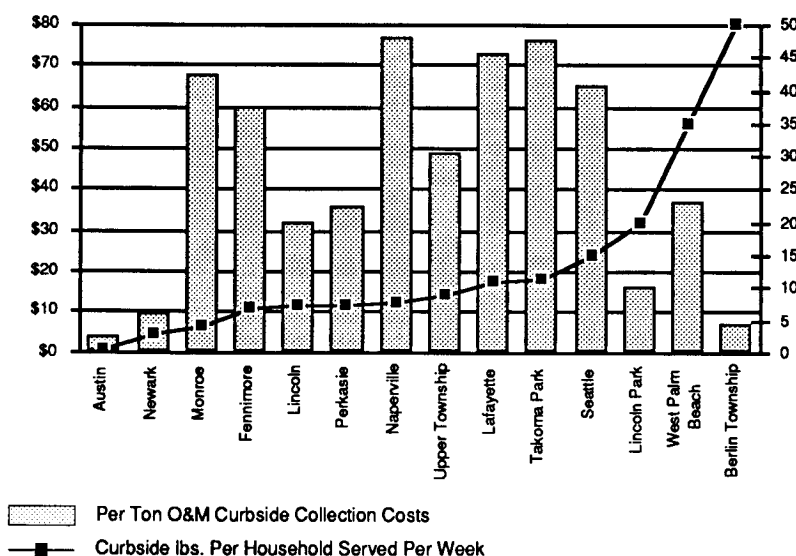
Depending on the collection route, Newark's collection vehicles must travel up to 20 miles to unload recyclable materials; furthermore, the trucks must unload three to four times a day. Newark incurred a curbside collection O&M cost of \$140 per ton in 1989. La Crescent incurs a curbside collection cost of \$111 per ton; haulers must travel between 10 to 40 miles to the County processing center, and the trucks unload twice per day. In Providence, where the curbside collection O&M costs are \$105 per ton, haulers must drive at least 15 miles one to two times per day to unload recyclables at the State processing center. In contrast, Fennimore has a low curbside collection O&M cost of \$39 per ton; although the service provider has to unload about six times a day, he travels only 1 mile to the City processing center. Perkasio's per ton collection O&M costs are about \$50. Its trucks travel less than a mile to deliver aluminum, steel, and newspapers; 10 miles to deliver plastic; and 15 miles to deliver corrugated cardboard. (While Perkasio's trucks may travel a number of miles to deliver its paper, they do not do this every day. Unlike in the other communities mentioned above, Perkasio delivers materials directly to markets, not to a processing facility.)

Reducing the number of times vehicles must unload can also

increase collection efficiency, thus reducing costs. Factors affecting unloading frequency include the capacity of collection vehicles, the density of materials collected, and whether or not materials can be compacted en route.

Some communities are using compactor trucks to collect recyclables, especially waste paper. Compacting material increases truck tonnage capacity and reduces the unloading frequency; this in turn improves collection efficiency, which reduces costs. The fact that Perkasio, Boulder, and Upper Township compact significant portions of their recyclables may contribute to their relatively low recycling collection costs. Perkasio collects mixed waste paper and corrugated cardboard in two different packer trucks, and incurs collection costs of about \$50 per ton. Boulder and Upper Township similarly collect paper in separate packer trucks; their collection costs are \$51 per ton and \$71 per ton, respectively. Columbia uses a packer truck

Chart 8.7
Yard Waste O&M Curbside Collection Costs and Pounds Collected Per Household



Notes: Pounds per household per week was calculated on a 52 week year even for cities with seasonal collection. Fennimore's pounds collected at curbside may include some drop-off material. Lincoln Park, Berlin Township's, and Monroe's curbside costs include a small amount of drop-off expenses. Lafayette's annual tons are prorated based on 650 tons per month for 5 months while the program was in operation. And, its costs also cover the collection of 963 tons at the drop-off. West Palm Beach's curbside cost and tonnage includes a significant amount of residue material that was not composted. Excluding this residue, the City composted 26 lbs./per household at a cost of \$50/ton.

Table 8.19
Factors Affecting Collection Efficiency and Costs

Community	Curbside Collection O&M Cost (\$/ton)	Distance to IPC (miles)	Number of Times Truck Unloads Per Day	Truck Type	Number of Crew Members	Number of Stops Per Day Per Vehicle
Fennimore, WI	\$39	0.5	6	Used BeerPop Truck	2	400-500
Monroe, WI	\$50	1	3	Modified Dump Truck	1	750-900
Boulder, CO	\$51	0 (a)	NA	Retrofitted Packer Truck	2	NA
Seattle (north), WA	\$54	NA (b)	2	18- and 31-cy Trucks	1	400
Perkasie, PA	\$58	0-15 (c)	1	Trailer	4	280
Berlin Township, NJ	\$58	10	1	Eager Beaver Truck	1-2	600
Berkeley, CA	\$63	0-4	1-2	Lodal Trucks	1-2	NA
Upper Township, NJ	\$71	0.5-15	1-2	20-cy Packer Truck	3	400
Naperville, IL	\$73	0.25-15	1-2	1-ton Truck with Trailer	2-3	NA
La Crescent, MN	\$111	10-40	2	Retrofitted Vehicle	3	500
Takoma Park, MD	\$97	4-12	1-3	Kahn Sorter Truck	3	800
Providence, RI	\$105	15	1-2	31-cy Labrie Truck	1	NA
Newark, NJ	\$140	1-20	3-4	23-cy Eager Beaver Trucks & Trailers	3	NA
West Palm Beach, FL	\$148	16-51	1	30-cy Labrie Truck	1	NA
Philadelphia, PA	\$173	1-10	1-2	23-cy and 32-cy Lodal Trucks	3	NA
Lafayette, LA	NA	0-15	2-4	15-cy Eager Beaver Trailers	3	400-900

Key:
cy = cubic yard IPC = Intermediate Processing Center NA = Not Available

Notes:
For details on per ton collection costs, see Table 8.13.
(a) Site is within city limits.
(b) Trucks take one hour for a round trip.
(c) Distance is 10 miles for plastics and 15 miles for newspaper.

to collect old corrugated cardboard; its collection costs are \$49 per tin.

Since plastic wastes are a low-density material, collecting them can reduce efficiency. To meet this challenge, several communities such as Monroe²⁰ and areas of Portland are using plastics compactors on their collection vehicles. The hauler providing collection service in West Linn, which began plastics collection in 1991, uses an on-board compactor. An alternative to the plastic compactor is the on-board plastic grinder, which combines different resins en route; the resins are later separated through a flotation process. This method is being used in Ann Arbor, Michigan, and is being tested by waste haulers in Portland in conjunction with Partek Inc. in Vancouver, Washington, which

developed the system.²¹ (Before investing in a plastics grinder, communities should ensure that ground plastic meets the specifications of targeted markets.) In communities that target a wide range of materials for collection, including plastics--Berlin Township, Fennimore, Monroe, Naperville, and Upper Township--per ton collection costs remain below \$80 per ton.

While seven of our 30 communities have bottle bills in effect in their areas, curbside collection costs are available only for two of these Berkeley (\$67 per ton including processing) and Columbia (\$49 per ton)--both in the moderate range. Collection costs in these bottle bill communities might be low as a result of avoiding the collection of high-volume beverage containers.

Yard Waste Composting Programs

Yard waste collection costs vary widely among our 30 communities, but tend to be lower than recycling collection costs. See Tables 8.4 and 8.6. Yard waste is more homogeneous than the various types of recyclables; it can be compacted; and it can be collected in one vehicle. Thus, yard waste collection systems can be very efficient. In addition, a number of our case-study communities have avoided investments in equipment for collecting yard waste by using existing collection vehicles for this purpose. By targeting yard waste for collection, cities can reduce total per ton materials recovery costs.

Several communities collect yard waste with low operating costs. Berlin Township, for example, collects bagged leaves and grass clippings weekly year-round with dump trucks, and loose leaves in the fall with a specially designed scoop. Its average O&M collection costs in 1990 were \$7 per ton.²² In Lincoln Park, bagged leaves and grass clippings are picked up twice a month in the spring and fall with packer trucks. Loose leaves are picked up as needed in the fall with a vacuum pulled by a dump truck. In addition, 40 percent of the yard waste collected in 1990 was collected through the drop-off site. The Township's O&M cost for yard waste collection that year averaged \$16 per ton. The City of Newark contracts with three private haulers to collect leaves, grass clippings, brush, and Christmas trees at curbside weekly from October through January. Haulers use packers and dump trucks. The City's cost is \$10 per ton. In Lincoln, the City incurred \$14 per ton in yard waste O&M collection costs. Private haulers under contract with the City collect leaves, grass clippings, and brush using packer trucks. These materials are set out in 90-gallon totes weekly July through November. Two of the three contracted haulers chose to replace one of their two weekly refuse collection days with yard waste collection, and charged the City only \$8 per ton of material collected. (If participation in this voluntary program had been mandatory, this fee probably would have covered costs; however, because the program was voluntary and participation low, the City provided the haulers additional reimbursement based on a nonparticipation formula.) These two haulers determined they could offer yard waste collection service to residential households for \$2.70 per

month, which is equivalent to the cost of adding a second weekly refuse collection day.

Upper Township and West Palm Beach also have relatively inexpensive yard waste collection programs, at \$49 per ton and \$37 per ton, respectively, for O&M costs. Both towns collect yard waste year-round using two-person crews with compactor trucks. Takoma Park's program is more expensive, with average O&M costs of \$76 per ton in 1990. It collects yard waste year-round, but uses three- to five-person crews. Seattle, Naperville, and Lafayette contract with private haulers for yard waste collection. Lafayette's contract is based on a per household fee and Seattle's on a per ton fee. Naperville pays its hauler the equivalent of \$111 per ton for weekly collection of grass clippings and other garden trimmings, April through December. The City undertakes fall leaf collection and brush collection. The following year, the City established a new yard waste collection system in which residents were charged directly per bag of yard waste set out.

Composting costs, like processing costs for recyclables, are highly influenced by the technology utilized, the amount of material composted by the facility, and the number and wages of employees. Many communities are avoiding composting costs by relying on county or private facilities that charge minimal or no tipping fees. For those that are composting their yard waste at local facilities, composting operating costs range from \$2 per ton in Berlin Township to \$89 per ton in Philadelphia, with most costs in the \$15 to \$30 range. Capital costs per ton-per-day composted are relatively inexpensive, ranging from virtually \$0 in Fennimore to \$54,660 in Austin. At Austin's site, a front-end loader mixes yard waste with sewage sludge; the combined material is turned with a windrow turner twice a week, and after several months of composting and curing, is screened. On the other hand, the only equipment Fennimore uses is a 1975 front-end loader to turn windrows.

Communities can substantially reduce both collection and processing costs by promoting backyard composting of organic materials and leaving grass clippings on lawns. (See Chapter 3 for a description of backyard composting programs.)

Outside Processing and composting Facilities

Local communities can avoid and/or reduce capital and operating costs by sending recyclables and yard waste to processing facilities owned by County or State agencies, or by private firms. (Regional facilities benefit from economies of scale, and the overall operating expenses of such facilities are frequently cheaper than those of municipally scaled facilities. In many instances, total capital costs of regional facilities are higher.) While municipalities typically pay low or no tipping fees to use such facilities, drawbacks include additional

transportation costs, little control over the types of materials accepted, and little control over where materials are marketed.

Clearly, if municipalities take advantage of other publicly operated facilities, the costs of these facilities may still be borne by the taxpayer. County and state operations may be funded through such sources as taxes, bond issues, landfill surcharges, and, of course, materials revenues. Private sector recovery enterprises, on the other hand, operate as businesses and cover their costs through the fees they charge and the materials revenues they receive. (If private recycling processors or composers do not charge local,

Co-Collecting Recyclables and Mixed Waste: Problems and Opportunities

Co-collection is an alternative curbside collection method in which refuse and source-separated recyclables are collected simultaneously using the same vehicles. Residents place their recyclables in rigid containers or special bags. Haulers collect all materials at the same time, placing them in the refuse compartment, retrofitted recycling bins, or trailers. There are two basic methods for co-collection: the bag method and the bin method. In the bag method, residents commingle recyclables in one or more color-coded bags and set the bags out at curbside with their refuse. (Some communities are using blue bags, others are using yellow or clear bags.) Haulers collect the bags of recyclables and the bags of refuse together in traditional packer vehicles. In the bin method, residents set out their recyclables in rigid containers alongside their bags of refuse. Haulers collect the recyclables and refuse in collection vehicles that have been retrofitted with recycling bins or trailers. At least 14 communities in the United States have tried either pilot or full-scale co-collection systems. Nine of these are bag systems and five are bin systems.

Co-collection may provide a simple, low-cost approach to the curbside collection of recyclables. In rural areas co-collection may be the only cost-effective option for a curbside program, because collection routes are long and the distance between households is too great to warrant separate collection vehicles.

Whether co-collection systems are cheaper than dedicated curbside recycling systems is not yet clear. Trade-offs in costs occur between collection and processing. Operating and maintenance costs for collecting recyclables will likely be cheaper in a co-collection system, but processing recyclables will be more expensive, especially for the bag system. Bags of recyclables must be sorted from the bags of refuse and then sorted by material. In all the bag systems currently operating, bags of recyclables are manually sorted from bags of refuse. For systems with minimal recycling, handling costs may be low. Removing a few color-coded bags of recyclables from a truck may not impact costs too greatly; as these bags increase in number, the handling cost to separate them from refuse bags will increase. Thus, in communities that plan to maximize recycling, the extra cost of double-handling bags of refuse and recyclables on sorting floors may be high. The processing stage for bagged recyclables is either labor-intensive or capital-intensive, depending on whether sorting is done primarily by hand or by machine. On the other hand, separate collection of recyclables using the bin method or dedicated recycling trucks may require much less sorting and materials preparation, depending on the level of en route sorting.

In Omaha, Nebraska, which uses a bag co-collection method, the per ton collection cost for refuse and recyclables is \$32. Omaha's cost to process bagged commingled recyclables is \$96 per ton, up from

county, or state governments for handling materials, these operators' costs are typically being covered by materials revenues, not by the taxpayer.)

Providence, La Crescent, West Palm Beach, Austin, San Francisco, Berlin Township, Upper Township, Takoma Park, Newark, and Columbia all avoid the costs of processing recyclables. The State of Rhode Island pays for processing of Providence's recyclables. The counties in which La Crescent, Berlin Township, Upper Township, Takoma Park, and West Palm Beach are located own and operate processing facilities, and do not charge a tipping fee.²³

In Austin, San Francisco, Newark, and Columbia, processing facilities are privately owned and do not charge a tipping fee. The City of Newark actually received \$12 for each ton it delivered to the private processing facility during the base year of study. Relying on private companies for processing recyclables has kept processing costs low in Boulder, Lincoln, and Philadelphia. Their processing costs are \$5, \$15, and \$8 per ton, respectively.²⁴

Composting, too, is often undertaken by the private sector or county agencies. Private facilities often charge tipping fees, but by using these facilities communities can avoid incurring capital

\$42 a ton in 1991. The City's contracted processor cites the labor-intensive nature of sorting recyclables as the primary reason for the increase in costs. On top of this, the processor charges \$6 a ton to separate bags of refuse from bags of recyclables. In Hamburg, New York, where conventional trash trucks pull trailers for sorted recyclables, collection costs for refuse and recyclables are \$63 per ton. While processing adds another \$41 for every ton recycled, landfilling costs \$45 for every ton disposed.

The main disadvantages of the bag co-collection method include glass breakage and material contamination, which may result in lower recovery rates. Glass breakage, in particular, compromises the quality of the materials collected. Communities with bag programs report that from 10 to 25 percent by weight of the collected glass breaks. Pullman, Washington solved this problem by requiring residents to set out glass in separate bags from other recyclables; haulers then place the glass in a side rack on the packer truck. However, other communities have had to reduce the compaction rate on their garbage trucks in order to mitigate material contamination and bag breakage problems. This, of course, reduces vehicle tonnage capacity and increases unloading frequency, which in turn will increase costs. Participation rates for programs requiring residents to buy bags at local stores have been lower than for programs providing recycling containers. As a result, less tonnage will be collected for recycling and per ton recycling costs may be higher than in similar programs with higher participation.

Unlike the bag method, the bin method of co-collection involves an initial capital investment for the purchase and installation of collection bins. This investment is small compared to the costs of new recycling vehicles needed for dedicated curbside recycling programs. A hauler can expect to spend about \$20,000 to convert an existing refuse truck to co-collection (including cost of bins, extending frame, and reducing packer area). Similar to more segregated dedicated recycling collection systems, bin co-collection systems have experienced fewer problems with material contamination and processing than the bag co-collection systems. One problem with the bin method has been the inflexibility of compartment capacities. One compartment of one bin may fill up more quickly than the other compartments or the refuse area. (This, of course, also occurs with compartmentalized recycling vehicles.) Loveland Colorado operated a pilot program for several months in which it experienced these problems: different neighborhoods set out different quantities of recyclables and refuse, making it difficult for the City to develop accurate volume estimates for its vehicles. Loveland addressed this problem by designing compartments large enough to handle half of each truck's assigned daily collections rather than designing a truck with compartments that would fill up simultaneously.

Source: Brenda Platt and Jill Zachary, *Co-Collecting Recyclables and Mixed Waste: Problems and Opportunities* (Washington, DC: Institute for Local Self-Reliance), 1992.

costs for equipment and be relieved of operating and marketing responsibilities.

Takoma Park, Upper Township, and West Palm Beach use County composting facilities that charge no tipping fees for a large portion of their yard wastes. While Takoma Park composts the leaves it collects during the fall at a City site and Upper Township incurs costs for brush recovery, the use of County facilities keeps O&M and capital costs low in both these municipalities.

Dakota County avoided capital investments in composting equipment by contracting with a private company to operate two County-owned composting sites. The operator owns all the equipment. In 1990 composting fees were relatively low at \$33 per ton.

Berkeley and Seattle also use private composting facilities. Berkeley pays \$24.75 per ton of yard waste delivered, and Seattle pays \$5.47 per ton for the first 24,000 tons delivered and \$18 per ton for any tonnage above that.

As Tables 8.1, 8.2, and 8.7 indicate, the capital cost of the typical composting facility is relatively low, and communities may find it more cost-effective (particularly when considering transportation costs) to operate their own facility rather than pay tipping fees at private sites. Berlin Township, for instance, is applying to a local commission for the right to compost grass clippings and brush on a local site, so as to avoid the \$7 per cubic yard tipping fee that it is currently incurring.

Integrating Materials Recovery Into Solid Waste Systems

When implementing materials recovery programs, cities generally incur additional capital and operating expenses. These additional costs can be offset by reduced costs of managing solid waste destined for disposal. While some additional expenses cannot be avoided, communities can reduce such costs by shifting staff and equipment away from refuse collection to materials recovery. Materials recovery programs serve as substitutes for refuse collection and disposal systems not additional programs. Berlin Township, for example, has one of the least expensive curbside recovery programs in our study and utilizes the same staff and much of the same equipment for

refuse and recycling activities. Rather than adding a whole new collection system, some communities, such as Perkasié, Naperville, and Takoma Park, have replaced one of their two weekly refuse collection days with recyclable and/or yard waste collection. Takoma Park reorganized its Sanitation Division at the beginning of its curbside program to avoid hiring additional personnel to collect recyclables. The City reduced the number of trucks collecting refuse and converted one of its three-person crews to a recycling crew. After reaching a 36 percent recovery rate in 1990, Takoma Park reduced refuse collection from two days a week to one day in 1991, and split sanitation crews evenly between recycling and refuse collection.

Many communities in our study have avoided new equipment purchases by using pre-existing or shared equipment. In Berkeley, Berlin Township, Fennimore, Columbia, Lincoln, and Monroe, equipment used for collecting refuse or other public works functions (such as front-end loaders and dump trucks) are also used for collection of recyclables and yard waste, and in several cases for processing these materials as well. Table 8.20 lists equipment that communities use for recycling and/or composting that was owned before the initiation of the program.²⁵ Much of this equipment continues to serve several functions, with recycling and composting accounting for a small percentage of the time they are in operation.

Co-collection systems present another way to more fully integrate recycling into solid waste management. (See side bar "Co-collecting Recyclables and Mixed Waste; page 138.)

Refuse and Materials Recovery Costs

While there is certainly variation in the cost-effectiveness of different materials recovery programs and much room for such programs to lower costs and increase efficiency, the operating cost of materials recovery is less than for refuse collection and disposal in most of our 30 communities for which this information is available.

Chart 8.8 compares materials recovery O&M collection and processing costs to refuse collection and disposal costs. For most of the communities, refuse collection and disposal costs are significantly

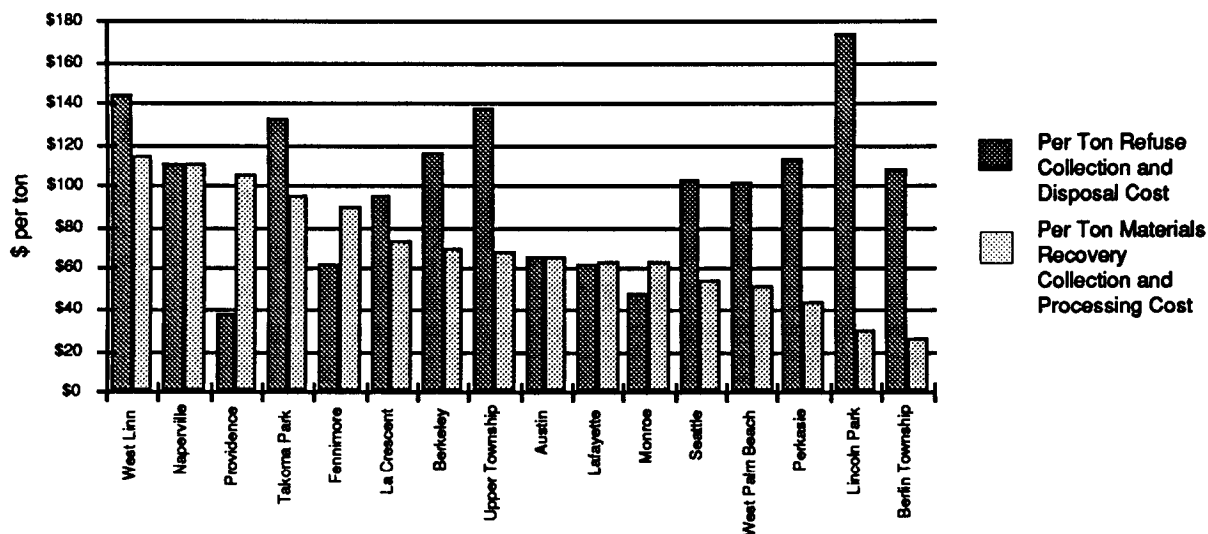
Table 8.20
Shared, Pre-existing, and Retrofitted Equipment

Berkeley, CA	Berkeley uses a packer truck, which predates the program, for yard waste collection.
Berlin Township, NJ	For collection, a loader is used 5% for recycling and 95 percent for DPW use; a 1-ton dump truck is used 20 percent for recycling and 80 percent for composting; a Ford 555 backhoe loader is used 35 percent for recycling, 15 percent for composting, and 50 percent for DPW use; a dump truck is used 35 percent for recycling, 15 percent for composting, and 50 percent for DPW use; a Ford F800 dump truck is used 35 percent for recycling, 15 percent for composting, and 50 percent for DPW use; a 3/4-ton dump truck is used 50 percent for recycling and 50 percent DPW use; a stake body dump truck is used 50 percent for recycling and 50 percent for DPW use.
Boulder, CO	Four front-end loaders are used six percent of the time and 20 trucks are used six percent of the time for mulching. The remainder of the time, the equipment is used by the DPW.
Bowdoinham, ME	A converted Chevy fire truck, which was purchased prior to the onset of the program, is used for processing recyclables.
Columbia, MO	A 25-cubic-yard packer truck, which was used by the DPW for refuse collection prior to the initiation of the recycling program, is utilized for collection of recyclables and compostables.
Dakota County, MN	For the office paper collection program, a used truck was purchased.
Fennimore, WI	For collection of recyclables, a beer/pop truck was purchased and retrofitted. A dump truck is used 10 percent of the time for compost collection; the rest of the time it is used by the DPW. An end-loader, which was purchased prior to the onset of the composting program, is used for composting.
La Crescent, MN	A front-end loader is used for compost 40 percent of the time; the rest of the time it is used by the DPW.
Lincoln, NE	A front-end loader is used for composting 10 percent of the time. The rest of the time, the loader is used by the DPW.
Lincoln Park, NJ	A dump truck is used 30 percent for collecting recyclables and 30 percent for collecting yard waste. The remainder of the time it is used by the DPW.
Mecklenburg Co, NC	Two Mack roll-offs are used 75 percent of the time, and three 24-cubic-yard front-end loaders are used 90 percent of the time at the recycling drop-off. The rest of the time, the equipment is used by the DPW.
Monroe, WI	Two dump trucks used for collecting recyclables were owned prior to the onset of the recycling program; a packer truck utilized for yard waste collection is used 75 percent of the time (the rest of the time it is used by the DPW) and was purchased before the onset of the composting program.
Naperville, IL	A dump truck is used for composting and street maintenance. Two vacuum sweepers are used for yard waste collection 20 percent of the time; the rest of the time they are used by the DPW.
Newark, NJ	A 31-cubic-yard packer truck, which was purchased before the onset of the program, is used for collecting recyclables. A chipper is used for composting six percent of the time; the rest of the time it is used by the DPW.
Takoma Park, MD	Three compactor trucks are used 10 percent of the time for collecting recyclables and 10 percent for collecting yard waste. The rest of the time, they are used by the DPW. The equipment was acquired before the program began.
Upper Township, NJ	A chipper is used for composting 10 percent of the time and the rest of the time by the DPW.
Wapakoneta, OH	A dump truck is used for yard waste collection 10 percent of the time (the rest of the time it is used by the DPW). A 20-cubic-yard packer truck, bought prior to the onset of the commercial waste recycling program, is used for collecting old corrugated cardboard.
West Linn, OR	A 20-cubic-yard packer truck is used for collecting recyclables 20 percent of the time; the rest of the time it is used by the DPW.
West Palm Beach, FL	A flat-bed truck is used for collecting recyclables 40 percent of the time; the rest of the time it is used by the DPW.

Note:

"Percent of the time" refers to the proportion of time the equipment is in use.

Chart 8.8
Net O&M Cost for Materials Recovery Collection and Processing
Versus Refuse Collection and Disposal



Notes: Some communities are missing from chart because either their refuse collection and disposal costs or their net O&M per ton collection and processing cost were not available. The per ton refuse collection and disposal cost and the net per ton O&M costs for materials recovery exclude administrative overhead.

higher than the costs for recovery of recyclables and compostables, especially in areas where tipping fees are high, such as Lincoln Park, Upper Township, and West Palm Beach, where 1990 per ton tipping fees were \$119, \$89, and \$84, respectively. In the few areas where costs were lower for refuse collection and disposal than for the materials recovery program, tipping fees were generally quite low--\$14 per ton in Providence (1990), \$10 per ton in Austin (1989), free for 3 months in 1990 and \$32 per ton the remainder of the year in Fennimore, \$15 per ton in Monroe (1989). Worth noting is Monroe's calculated savings of \$154,000 per year through the 15-year life extension of its landfill due to recycling as well as waste compaction at the landfill.

In Berlin Township, the collection cost for materials recovery is the same as for refuse collection and disposal, but the Township has to pay to market its waste paper (\$10 for every ton

recycled). Thus, the cost savings are really in the avoided tipping fee, which was \$65 per ton in 1990.

When the *Report on Future Expansion of the City of Philadelphia Recycling Curbside Collections* was issued in July 1991, Philadelphia's per ton cost for recycling was beginning to decrease, approaching that for refuse collection and disposal. The total cost for recycling was \$134 per ton in the northeast section of the City and \$201 per ton in the northwest section. Refuse collection costs were \$134 per ton and were projected to increase to \$137 in FY 1992. Since July 1991, the cost of recycling has dropped further and come within range of the cost of collecting refuse, spurring a decision to expand curbside collection into a new section of the City. The realization that recycling can be cost-effective compared to refuse collection and disposal, has also led Philadelphia to research methods of increasing its recycling program's efficiency.

Conclusion

This chapter has examined the major factors that determine how much a community will have to spend to recover its waste. While there is much variation in the cost of materials recovery, communities can lower the cost of their recycling programs, and consequently their solid waste systems, by improving the efficiency and design of these programs. While in most cases cities incur additional capital and operating expenses when implementing materials recovery, as the tonnage recovered increases, materials recovery no longer operates as an add-on program but rather can begin to replace a city's refuse collection and disposal

infrastructure. Improved market conditions for recyclables, resulting from increased demand for recycled goods, will also serve to lower net materials recovery costs. Yet, materials recovery programs do not have to pay for themselves. Eliminating refuse collection and disposal costs are driving the cost-effectiveness of recycling and composting programs. Where disposal costs remain low, collecting and processing recyclables alone may not be cost-effective. Waste prevention initiatives, yard waste composting, and attracting local manufacturers to use collected scrap may help improve the cost-effectiveness of overall recovery programs.

Notes

¹This chapter does not provide a comprehensive assessment of the costs of other solid waste systems, nor does it detail all the monetary, environmental, and social benefits associated with materials recovery.

²Per ton costs were calculated by dividing annualized capital costs by the annual tonnage recovered that the costs cover. Collection equipment was annualized over a 7-year period, while processing equipment was annualized over a 10-year period. Financing rates and actual pay-back periods were utilized only for those few communities incurring such fees. In Austin, Eager Beaver truck and trailers were financed with a 5-year loan at 10.67%. In Lincoln Park, roll-off truck was amortized over 5 years at a 6% interest rate; equipment for Philadelphia was amortized over 5 years at an 8.5% interest rate.

³In most cases, data represent communities' actual recycling and composting expenses; in a few instances, communities provided estimates of the percentage of their public works budget devoted to recycling and composting activities.

⁴In Table 8.11 per ton revenue represents the total revenue received by a community from the sale of recyclable and compostable materials divided by the total tonnage of materials recovered.

⁵Lincoln Park's capital investment is lower than Fennimore's, but its costs only cover a chipper for Christmas trees.

⁶Costs shown in Chart 8.1 for West Linn represent drop-off program costs only, since curbside collection is carried out by the private sector.

⁷Due to inadequate information, the costs for private collection are not evaluated here. These costs are incurred directly by residents, and in most cases, are covered by refuse collection fees.

⁸Curbside recycling bins comprise a large percentage of Lafayette's capital costs. Many communities with contracted service do not incur the cost of bins. This cost may become less significant as the program recovers more material.

⁹This excludes the cost and tonnage of the City's publicly sponsored but privately collected food waste recovery program, which, at \$67 per ton, would lower O&M recycling costs to \$158 per ton and total costs to \$242 per ton. Both recycling totals exclude an unknown amount of administrative expenses incurred by the Department of Sanitation.

¹⁰Seattle recently renegotiated its contract. In 1993 Waste Management will receive \$78 per ton and Rabanco will receive \$84 for the collection and processing of recyclable materials. These amounts will be adjusted in accordance with changes in the market price for recyclables. The City anticipates that with predicted improvements in paper markets, the actual per ton cost for recycling will be \$71 to \$72.

¹¹Wapakoneta, Peterborough, and Lincoln Park have drop-off programs. The Borough of Lincoln Park collects newspaper at curbside, and Peterborough has limited private sector curbside service.

¹²Lafayette's low cost of \$39 per ton does not represent actual program costs. The Recycling Foundation a nonprofit organization formed by two owners of a local bottling plant, renegotiated its contract with the City the following year and its contract fee tripled.

¹³The average cost to collect and process recyclables in Rhode Island is estimated at \$126 per ton; disposal of residue cost \$44 per ton; and lost revenue due to broken glass is estimated at \$30 per ton in 1991. For every ton of glass collected for recycling that is actually landfilled, Rhode Island loses \$200. Janet Keller, "The nitty-gritty of glass recycling: Reducing glass breakage in collection and processing," *Resource Recycling*, February 1992, 46-55.

¹⁴Ibid.

¹⁵According to the Assistant Commissioner of Transportation in New York City, a City that uses glassphalt in paving projects, glassphalt replaces a maximum of 10 percent of the total crushed aggregate added to paving material, and virgin-material-based aggregate is valued at only \$10 to \$12 per ton. Clear cullet price is for the East Coast. *Recycling Today*, Municipal Edition, February 1992; and Assistant Commissioner Most, New York Department of Transportation, New York City, personal communication, May 1992.

¹⁶"Privatizing Municipal Waste Services: Saving Dollars and Making Sense," National Solid Waste Management Association, Washington, DC, undated.

¹⁷See footnote 10.

¹⁸In 1992 Berkeley negotiated a 7-year, \$9.7 million contract with the Ecology Center for the provision of curbside recycling services to the City.

¹⁹While this arrangement benefits the City of Berkeley, it has not always benefited Urban Ore, which has found that surrendering 10 percent of gross revenues may cause a net loss, especially when gross costs approach gross revenues. A fairer arrangement might be based on a percentage of net revenues.

²⁰Monroe purchased a compartmentalized vehicle with an on-board compactor in October 1991.

²¹"Portland Puts Plastic Grinders On Trucks: *Recycling Today*, June 1991.

²²Berlin Township does not weigh its yard waste. It converts volume to weight using conversion factors supplied by the State of New Jersey Department of Environmental Protection. See Appendix C. National conversion factors are more conservative than these New Jersey figures. Using more conservative figures (500 pounds per 1 cy of compacted leaves) would raise Berlin's collection costs to \$9 per ton.

²³Berlin Township does have to pay private waste paper recyclers to take its waste paper. The County facility does not handle paper. Takoma Park did not start using the Montgomery County processing facility until September 1991, soon after it opened. This facility also does not accept waste paper. The processing costs provided for Takoma Park in Tables 8.13 through 8.17 and in Charts 8.1 and 8.2 reflect costs in 1990, when the City paid a hauler to recycle its commingled food and beverage containers.

²⁴The \$8 per ton figure for Philadelphia is based on a weighted average. The City delivers its curbside recyclables to two processing facilities. The City is charged \$30 per ton at the PTRC and receives \$5.08 per ton at The Forge.

²⁵Pre-existing equipment is excluded from capital cost figures listed in this chapter.